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THE MIAMI SERIES OF SOILS.

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INTRODUCTION.

The Miami series comprises an important group of soils which are distinguished by prevailing brown, light-brown, or gray surface soils and yellowish-brown or darker brown subsoils. In the heavier members of the series, especially where the natural drainage is not complete, the deeper subsoils are mottled with shades of brown and gray.

The topography of the different members of the series ranges from nearly level or only gently undulating to more rolling and ridged. Locally, sharply sloping ridges and small areas in which erosion has developed a choppy surface are encountered. By far the greater part of the area occupied by the important types of the series is best described as gently undulating to moderately rolling.

The natural drainage over a large part of the territory occupied by this series is fair to good. In the more nearly level tracts, particularly of the heavier soils, artificial underdrainage is highly beneficial.

In its original condition practically the entire extent of territory occupied by the soils of this series was heavily forested with hardwoods. Beech was the dominant growth on the more nearly level tracts, while sugar maple was most commonly found in the more rolling and better drained areas. Associated with these trees were walnut, several species of oak, basswood, and elm and ash, the two latter in areas where drainage was markedly deficient.

The soils of the Miami series are all derived from a thick sheet of glacial drift which covers the general region of their occurrence, extending to depths varying from a few feet to more than 350 feet.

The deeper subsoils of the Miami series are generally calcareous to a varying degree, but it is a common characteristic of practically all of the surface soils that they are lacking in lime, and their agricultural value is generally increased by the addition of this material.

Note.—This bulletin is of interest to those engaged or desirous of engaging in farming in the North Central States.

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The soils of the Miami series do not occupy all the territory within which they are developed. In addition to these soils, and closely associated with them in the lower peninsula of Michigan and in portions of central Wisconsin, are those of the Coloma series. The latter are distinguished by light-brown to gray surface soils, yellow or reddish subsoils, and by their derivation from noncalcareous materials. They are prevailingly more gravelly and sandy than the soils of the Miami series.

Throughout all of the more nearly level areas occupied by the Miami soils there are large and small areas of soils which have dark-gray or nearly black surface soils and gray, drab or mottled subsoils. These soils are classed in the Clyde series, and are distinguished by the large quantities of organic matter which have accumulated in the surface soil. They occupy areas in which obstructed drainage gave rise to small ponds, or to swamps. They occur in the depressions and level areas lying between the low swells and ridges occupied by soils of the Miami series.

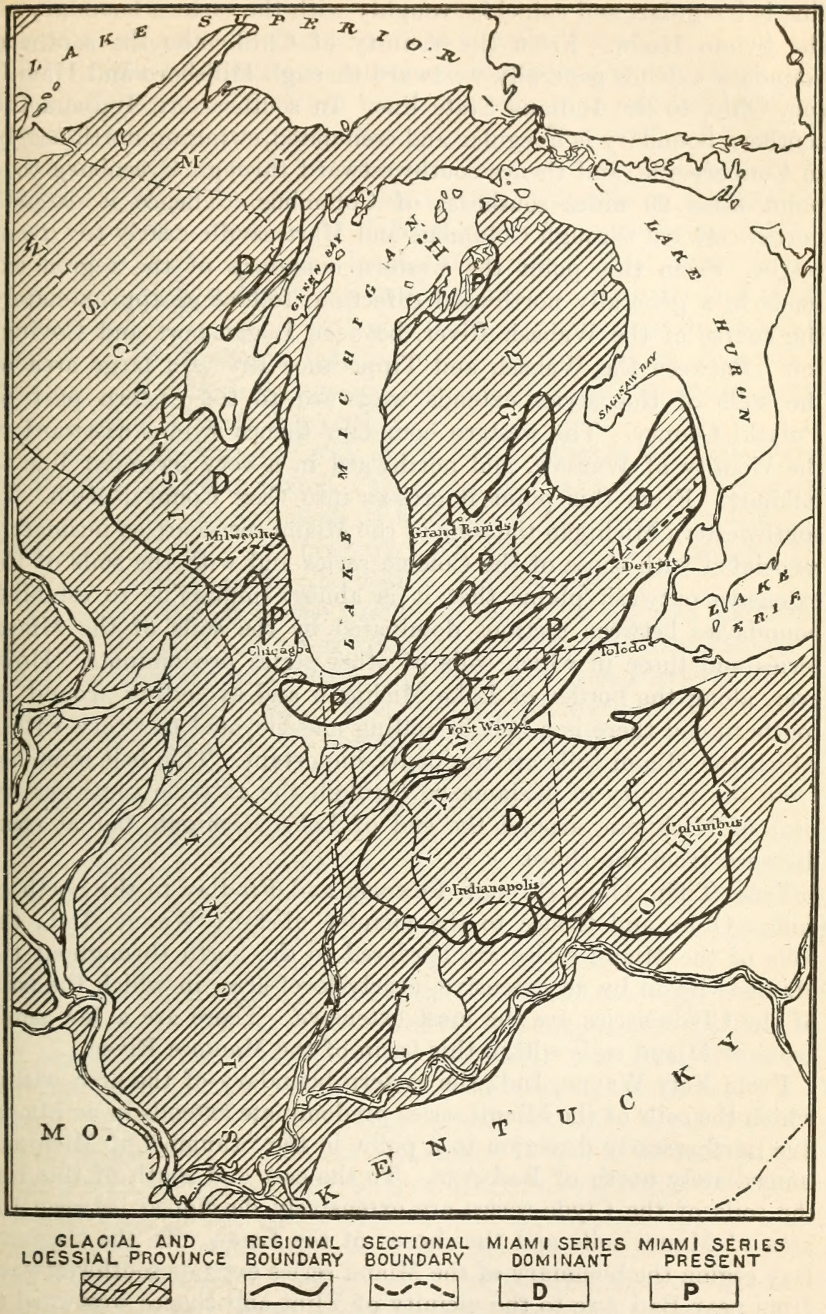
Toward the western boundary of the Miami series these soils are associated with dark-brown or black soils, which are classed as the Carrington series. Originally the Carrington soils were mainly prairie. They are of glacial origin, and usually calcareous in the subsoils, but are distinctly and uniformly much darker in color than the soils of the Miami group.

In nearly every area in which the soils of the Miami series are encountered there are also found extensive areas of water-worked and stratified soils of glacial origin which were deposited either as terraces along streams issuing from the melting ice or in the form of nearly level outwash plains of varying size. Several different series of soils have thus been formed. They are all distinguishable from the soils of the Miami series through the presence of stratified beds of sand and gravel at or near the surface and through the predominance of gravelly and sandy soils.

GEOGRAPHICAL DISTRIBUTION.

The soils of the Miami series occur most extensively in the western part of Ohio, the central and northeastern part of Indiana, in southern Michigan, south of a line connecting Bad Axe and Muskegon, in the Traverse Bay region of Michigan, in extreme northeastern Illinois, throughout eastern Wisconsin, and in a portion of the upper peninsula of Michigan, adjoining Green Bay. The location of the Miami series of soils is shown in figure 1.

The eastern boundary of the region dominated by the soils of the Miami series extends southward from the vicinity of Tiffin, Ohio,



GLACIAL AND LOESSIAL PROVINCE | REGIONAL BOUNDARY | SECTIONAL BOUNDARY | MIAMI SERIES DOMINANT | MIAMI SERIES PRESENT

D | P

FIG. 1.—Map showing distribution of the Miami series of soils.

through Bucyrus and Columbus to the vicinity of Chillicothe. The line is irregular, and coincides roughly with the eastern boundary of the Scioto Basin. From the vicinity of Chillicothe the southern boundary extends generally westward through Hillsboro and Hamilton, Ohio, to the Indiana State line. In southeastern Indiana the southern boundary is irregular and crenulated, swinging north nearly to Connorsville, and thence southwestward through Greenburg to a point some 20 miles southeast of Columbus. Thence it extends northwestward through Columbus and Martinsville nearly to Greencastle. From this point the western boundary of the region extends in a generally northward direction, following approximately the course of the Wabash River, between Logansport and Covington. Between the Wabash and Tippecanoe Rivers a large area of the soils of this series extends westward to the eastern part of Pulaski County. The western boundary thence swings eastward to the vicinity of Warsaw, and northward in a very irregular line to Elkhart. From this point it crosses into Cass County, Mich. In southwestern Michigan the soils of the Miami series are so intimately associated with those of the Coloma series and with the soils of the extensive outwash plains that it is almost impossible to establish boundaries between sections dominated by the soils of the Miami series and those in which soils of other series predominate. However, along the border of Lake Michigan and extending around its southern end there is a belt of rolling and elevated territory within which the Miami soils are decidedly important. This belt stretches from the vicinity of Kalamazoo through the extreme southwestern part of Michigan, around the end of Lake Michigan, but at some distance from the shore.

From Tiffin, Ohio, through Fostoria and Findlay to the north of Lima, Ohio, and thence to the vicinity of Fort Wayne, Ind., the soils of the Miami series are bordered to the north throughout the Maumee Basin by an extensive, nearly level area, in which the soils of the Clyde series are the most extensive. There are a few small areas of Miami soils within this basin of the Maumee River.

From Fort Wayne, Ind., the eastern boundary of the area within which the soils of the Miami series predominate extends in an almost due northeasterly direction to a point in the "thumb" of Michigan immediately north of Bad Axe. To the east and south of this line the soils of the Clyde series are extensively developed between the area of Miami soils and the shores of the Lakes. In the Saginaw Bay region the boundary of the Miami series extends southwestward from near Bad Axe to the vicinity of Flint and thence westward to a point a little to the northwest of St. Johns, Mich. Thence it fol-

lows an irregular course to the north as far as the northern boundary of Gladwin County, thus extending around the shore line of Saginaw Bay at a distance varying from 25 to 50 miles inland.

From the southwestern corner of Ogemaw County, Mich., the boundary of the area within which the soils of the Miami series are chiefly developed extends southwestward to the vicinity of Newaygo, Mich., and thence southerly near the shore of Lake Michigan to St. Joseph. It will thus be seen that a large total area in the southern part of the lower peninsula of Michigan is occupied by the soils of this series, although soils of the Coloma and other series derived from the glacial outwash are closely associated with the soils of the Miami series, and that in some localities, as along the southern boundary of Michigan between Hillsdale and Three Rivers and thence northward to Kalamazoo, the soils of the Miami series occupy only a small part of the territory.

A disconnected area of soils of the Miami series is also encountered in the Traverse Bay region. It occurs as a narrow belt of elevated land along the eastern shore of Lake Michigan, extending from the vicinity of Manistee to Traverse City, Mich., and as a broader belt between Great Traverse and Little Traverse Bays.

In eastern Wisconsin the western boundary of the area dominated by soils of the Miami series extends from the immediate vicinity of Beloit northwestward through Madison and thence northward to the vicinity of Portage, Wis. Thence it extends irregularly northeastward to a point west of Oshkosh. Nearly all of the territory lying between this line and the western shore of Lake Michigan is occupied by the soils of the Miami series, although large areas of other important soils are intimately associated with them. This section is separated from a more northern area of Miami soils by the glacial lake deposits and by other soils of glacial origin covering a considerable area in the lowlands which surround the southern end of Green Bay, and extend south and west of Winnebago Lake.

While the regions as outlined contain all of the larger areas of soils of the Miami series which have been mapped in the progress of soil-survey work, it is probable that small local areas of the soils of this series may be encountered to the west of the territory indicated. There is little possibility of any extensive areas occurring in more southern and eastern localities. It should be held in mind that a wide variety of other soils of different origin and of different characteristics is associated with the soils of the Miami series within the area where these soils constitute the most extensive types, and the most important in agriculture. The detailed soil surveys of the individual county areas only can show the relative extent of the Miami and other soils and their intricate geographical distribution.

PHYSICAL FEATURES.

The soils of the Miami series occur in the northeastern part of the great Central Plain, which extends from the region of the Great Lakes southward beyond the Ohio River and westward beyond the Mississippi. The greater part of this area, especially the extensive tracts in western Ohio and in central Indiana, is drained by streams belonging to the Mississippi drainage system. Large areas in the northern region are drained by the small tributaries of the Great Lakes. In general, the region consists mainly of extensive plains which range from about 600 feet in altitude to extreme elevations of 1,500 feet above sea level.

The broader features of topographic relief within this region are primarily due to the elevation of the rock floor which underlies the surface deposits. The eastern border of the region is indistinctly separated from the more elevated Appalachian Plateau by a transition from the more rugged topography of the plateau to the gently undulating plains to the west. Along a large part of this border the difference in relief is not so pronounced as to form a distinct boundary, there being only a gentle gradation from hilly and dissected country into a region whose interstream areas are but gently undulating and within which the major streams occupy narrow or broad trenched valleys of no great depth. Along this eastern border the elevation of the plain ranges from about 700 feet, east of Chillicothe, Ohio, to approximately 900 feet immediately east of Columbus and about 1,000 feet to the east of Bucyrus. Near its eastern border that part of the plain occupied by the soils of the Miami series sinks gently toward the basin of Lake Erie, the northeastern border of the section following the ancient shore lines of the glacial lake which occupied the Maumee Basin. This shore line has an elevation of about 800 feet above tide level throughout its extent, from Tiffin, Ohio, to Fort Wayne, Ind. The eastern boundary of the area, extending from Fort Wayne to Bad Axe, Mich., has approximately the same elevation.

From the eastern border of this region in central Ohio the plains undulate westward, gradually increasing in elevation until a maximum altitude of 1,500 feet is attained over a small area in the vicinity of Bellefontaine. This marks the extreme altitude in an elevated ridge which extends in an almost due north and south direction from the vicinity of Bellefontaine to that of Hillsboro. This ridge varies from 25 to 40 miles in width and has an elevation of more than 1,000 feet. It constitutes a gently rolling watershed separating the drainage of the Scioto River from that of the Mad River and the Little Miami.

Another area within which the altitudes are greater than 1,000 feet lies along the southern portion of the Ohio-Indiana State line from near Portland, Ind., to the vicinity of Liberty. This rolling upland separates the drainage of the Miami River from that of the Whitewater River, while a branch of the same ridge lies between the latter stream and the eastern tributaries of the East White River. These ridges do not exist as distinct topographic features, but merely comprise the higher elevations in a rolling country between the principal drainage basins of southwestern Ohio and southeastern Indiana. With few exceptions, the local slopes and changes of elevation are very moderate. The plain merely swells to higher interstream ridges and sinks to the broad, terraced valleys of the present streams.

Toward the north the plain sinks in gentle undulations to the basin of Lake Erie and its continuation in the broad, flat drainage system of the Maumee River.

The greater part of central Indiana consists of a nearly level plain having a slight inclination toward the drainage basin of the Wabash River on the north and west and toward the course of the White River in the south-central part of the State. Along the Wabash this plain sinks to elevations of 700 to 800 feet. The southwestern and western borders of the region occupied by the soils of the Miami series do not greatly depart from the 700-foot contour line through much of this region.

North of the Wabash River the region is considerably more rolling, partly on account of the greater absolute elevation of the underlying rock formations and partly because the area is dissected by numerous large streams which have cut comparatively deep channels.

Beginning in extreme northeastern Indiana in the vicinity of Kendallville, an elevated area extends to the northeast past Hillsdale and Howell, Mich., to the vicinity of Lapeer. This rolling and ridged section has an extreme breadth of about 50 miles and lies chiefly above the 1,000-foot contour line. The elevation is due mainly to the altitude of the underlying rock which is near the surface, particularly in the vicinity of Hillsdale, and in part to the depth and ridgy character of the superficial glacial deposits over the more northern part of the ridge. From this ridge the land slopes to the southeast and the northwest in gently undulating or slightly ridged areas with intervening nearly level plains of varying size.

The only other elevations in excess of 1,000 feet in the section of southern Michigan where the soils of the Miami series prevail occur along the extreme northwestern border of the area.

The small detached area in the Traverse Bay region occupied by soils of the Miami series ranges in elevation from about 600 feet to approximately 900 feet above sea level. The elevations within small areas vary more widely in this section than in any other part of the more eastern development of the Miami soils. It is a territory of undulating to hilly topography, with small areas of nearly level land. The nearly level areas are chiefly occupied by soils of other series.

In general, the areas occupied by the soils of the Miami series in southern Michigan may be characterized as rolling to ridged in the more elevated portion as described, and as gently undulating plains through the greater part of central Michigan from Howell to the vicinity of Grand Rapids. The western and southwestern part of the lower peninsula is occupied by broad, low ridges parallel with the lake shore, with intervening extensive outwash valleys which do not usually comprise large areas of Miami soils.

The small sections of northwestern Indiana and northeastern Illinois included within the region of mainly Miami soils consist chiefly of broad, flat ridges whose highest elevations do not exceed 800 feet. The local variations in altitude are usually slight, and the slopes are gentle, except in minor areas.

In the portion of eastern Wisconsin which is largely occupied by soils of the Miami series the topographic features differ materially from those within the territory already described. The land along the western shore of Lake Michigan from Racine to the mouth of Green Bay has an altitude of about 600 feet, or an elevation of 20 to 40 feet above the level of the lake. From the shore of the lake it rises rapidly toward the west, elevations of 900 feet or more being attained along a line from the center of the Door Peninsula southwestward to the vicinity of Beloit, Wis. In part this altitude is caused by the elevation of the underlying rock floor; but the minor differences in elevation and slope, and to some degree the absolute altitude, are determined by the thickness of the superficial deposits which cover this region. The central ridge is marked by choppy, steeply sloping ridges with large and small intervening hollows and plains, which give an appearance of rugosity in marked contrast with the surface of the areas occupied by the soils of the Miami series in Indiana and Ohio. The rolling topography typical of southeastern Wisconsin is shown in Plate I, figure 1. Over a large part of the section in southeastern Wisconsin immediately west and northwest of the high central ridge there are long, rounded, nearly parallel hills which, with the intervening hollows, give a fluted aspect to the surface.

FIG. 1.—ROLLING TOPOGRAPHY OF THE MIAMI SERIES IN WAUKESHA COUNTY, SOUTHEASTERN WISCONSIN.

[Miami silt loam in the foreground; Miami gravelly loam on the hills.]

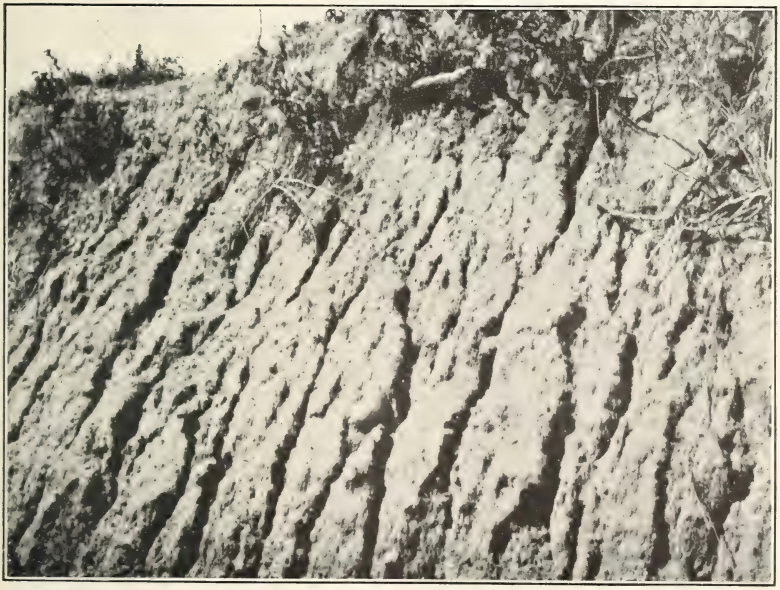


FIG. 2.—ROAD CUT IN GLACIAL TILL IN SOUTHERN MICHIGAN, SHOWING THE MINGLING OF STONES AND GRAVEL WITH THE FINER PARTICLES OF SAND AND CLAY.

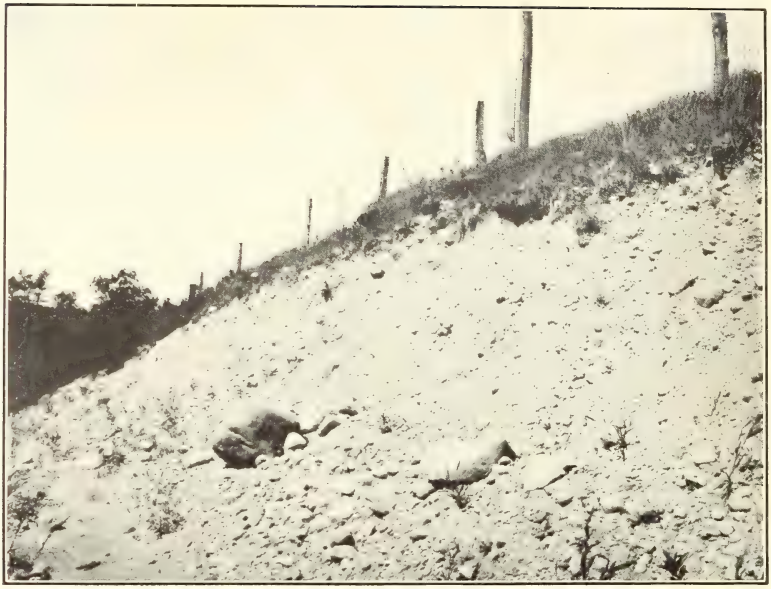


FIG. 1.—A CHARACTERISTIC CUT IN THE PARTIALLY WATER-SORTED DRIFT OF SOUTHEASTERN WISCONSIN.

[The material is sandy and gravelly, and gives rise to such soils as the Miami gravelly sandy loam.]

FIG. 2.—A LIMESTONE LEDGE, KEWAUNEE COUNTY, WIS.

[This rock underlies the rolling, glaciated upland. Glacial bowlders are seen in the stone fence.]

From this region the area occupied by the soils of the Miami series extends westward in broad, undulating swells, the elevation varying widely within the limits of a county, while smaller areas are usually smooth or rolling. A general elevation of 900 to 1,000 feet is maintained to the western border of the region of Miami soils near the Wisconsin River. Along the extreme western border some rough and hilly country is encountered within the known limits of the occurrence of soils of this group. The most notable example of this topography is found in the eastern end of the Baraboo ridge immediately west of Portage, Wis.

In general, the region occupied by the soils of the Miami series in Wisconsin not only possesses greater variations in elevation than the other sections dominated by these soils, but the local variations are greater, the slopes are more pronounced, and the surface is rougher and more complexly ridged than in the majority of the other regions.

ORIGIN.

All of the soils of the Miami series owe their origin to the glaciation of the region in which they occur.

Within recent geologic times practically all of the northern part of the continent was repeatedly covered by glacial ice. The ice advanced as far south as the region of the Ohio River and as far west as that of the Missouri. The successive advances and retreats of the ice each occupied a considerable period of time and gave rise to different deposits of materials which cover the central part of the United States to depths ranging from a few feet to a maximum of 400 or 500 feet.

The soils of the Miami series are developed chiefly within the territory which was most recently covered by the ice. This invasion is known as the Wisconsin stage of glaciation.

During the Wisconsin stage of glaciation the center of dispersion of the ice was undoubtedly within the region of the Canadian Highlands to the northeast of the Great Lakes. From this section the ice advanced as a thick sheet over all the territory to the south, extending as far as Chillicothe, Ohio, beyond Indianapolis, Ind., and into eastern and northeastern Illinois. It occupied the greater part of eastern and northern Wisconsin and covered considerable areas west of the Mississippi River.

In the region of the Great Lakes the ice sheet of the Wisconsin glaciation characteristically occupied the chief lines and basins of depression in the existing land surface in the form of broad tongues or lobes, which have been given the names of the important lakes, bays, and streams which now occupy these basins.

The ice sheet which occupied the basin of Lake Erie was continued southward in lobes which approximately coincided with the basin of the Scioto River, that of the Maumee and Miami Rivers, and another which extended westward through the Maumee Basin and overspread the northeastern and central part of Indiana as far as Indianapolis and the drainage of the Wabash River. From the deposits formed by this glacier the plains of western Ohio and eastern and central Indiana were formed, and these are extensively occupied by the soils of the Miami series.

Another large lobe of this glaciation extended southwestward through the Saginaw Bay region as far south as the northern part of Indiana. To the east its margin joined that of the Huron-Erie lobe, and the combined deposits of the two give rise to the rolling and hilly territory which extends southwestward from the "thumb" of Michigan to the vicinity of Logansport, Ind. It laid down the materials which constitute the ridged plains of central Michigan from Saginaw to the vicinity of Jackson and Kalamazoo. It did not extend entirely to the shore of Lake Michigan, but adjoined a larger lobe, which occupied the basin of Lake Michigan. Along the junction of these two lobes were formed deep and extensive deposits of ice-borne material along the eastern border of the lake from the vicinity of Newaygo to the Indiana State line.

The Lake Michigan lobe was almost coextensive with the present area of that lake, but extended slightly beyond its present boundaries, and laid down deposits which circle the lower extremity of the lake, giving rise to soils of the Miami series in northern Indiana and northeastern Illinois.

Another lobe of the Wisconsin glaciation extended to the southwest through the basin now occupied by Green Bay and Winnebago Lake. The front of this lobe and of the smaller Delavan lobe extended from the vicinity of Beloit, Wis., beyond Madison and Portage, and thence northward into central Wisconsin. Along the line of its juncture with the Lake Michigan lobe extensive and deep glacial deposits were formed which accentuate the area of highland separating the Green Bay basin from that of Lake Michigan.

When the ice sheet of the Wisconsin glaciation advanced to its extreme limit it extended over a region which had previously been glaciated one or more times. It filled the existing valleys and deeply covered the interstream ridges and hills. Its base rested upon the unconsolidated deposits of the previous invasions and upon exposed ledges of consolidated rock of various character and hardness. The ice scoured and eroded these surfaces, picked up masses of rock, gravel, sand, and clay, and after thoroughly mixing them transported the material a varying distance along its path. It is probable that a large part of this reworking and transportation was

accomplished beneath the ice and in the lower zones of the glacier. At the same time other materials, frequently derived from remote sources, were carried within the upper part of the glacier and upon its surface.

The glacial advance to the extreme limits of the Wisconsin stage of glaciation occupied a long period of time. There is also evidence that the ice front remained stationary, or nearly so, along the region of its extreme advance for some time, resulting in the thickening of the ice-deposited material along the outer margin of the glaciated region, forming hills and ridges of some elevation. These deposits are technically known as moraines, and comprise the material carried under, within, and upon the ice and piled up as a heterogeneous mass of stone, gravel, sand, and clay where the ice was melting along a nearly stationary position at its terminus. The outer margin of the area covered by the Wisconsin stage of glaciation is quite commonly marked by such morainal accumulations. Sometimes these moraines are heaped against more elevated land, which arrested the advance of the ice. Such moraines occur along the southeastern border of the area under discussion, particularly from near Chillicothe, Ohio, to the vicinity of Lancaster, Ohio. In other locations the front of the ice rested upon a nearly flat surface, and the morainal front rises from the outer plain like a low, irregular wall. The southern border of the region occupied by the soils of the Miami series is chiefly of this character from Chillicothe westward to the Wabash River and throughout a great part of the southwestern and western margin of this stage of glaciation.

From this position of its extreme advance the ice slowly receded, with numerous periods of halting and some stages of readvance over territory which had been once freed from its ice cover. At each of the stages of halting large or small marginal moraines were formed which still exist as low, rolling ridges, usually occupying long, narrow belts of higher land arranged concentrically with the margin of the individual ice lobes and around the extremities of the basins through which the various ice sheets advanced and retreated.

Between these swelling and rounded moraines the material which was carried under and within the ice sheet was distributed in the form of a thick sheet of clay, sand, gravel, and bowlders known as glacial till. A cut in this material is shown in Plate I, figure 2. This material does not differ greatly from that of the thicker morainal accumulations, except in having a more nearly level surface and in the lack of linear ridging and hummocky surface features. In general there are more extensive areas of water-washed and stratified material at some points within the moraine areas than within the till plains, although the work of the water from the melting ice is recognized to some extent in each of these forms of glacial deposition.

Bowlders and larger stones are more numerous within the moraine areas, especially those crystalline and other extraneous rock masses which were in all probability carried at or near the surface of the ice sheet. Large areas of the till plains are nearly stone free at the surface.

It is characteristic of the Wisconsin stage of glaciation that the thickest and most hilly areas of morainal deposition were formed between the lobes of the glacier invading the Lake region. Along such interlobate lines both lobes of the glacier deposited the included earthy and stony material as the ice melted. Along such lines also the action of water upon the glacial material was pronounced and many of the interlobate moraines consist of true unstratified till, of hillocks and ridges of water-washed and partly assorted gravel and stone, and of nearly level sandy areas. The associated hillocks, ridges, basins, and hollows, largely formed from stratified material, are commonly called kames. They differ from the morainal areas chiefly in the predominance of stratified drift and to some extent in the presence of kettle-shaped hollows inclosed between sharp ridges and knolls. A characteristic cut in such stony and sandy material is shown in Plate II, figure 1.

The melting of the glacier was accompanied by a greatly swollen condition of the streams which issued from the ice front. These streams carried large quantities of gravel, sand, and silt southward to the uncovered drainageways of the larger rivers. As a result the lower courses of the majority of the streams from the glaciated territory are bordered by terraces of water sorted and washed material not included in the Miami series of soils. In some instances partial readvances of the ice sheet covered such stratified deposits with a later sheet of till, and there are large and small areas of the Miami soils within the till plains which are underlain at various depths with stratified deposits of such origin.

In many instances the glacial drainage issuing from the interlobate moraines carried out sorted material which was deposited over broad frontal plains in the form of outwash aprons and terraces along drainageways. While these areas do not give rise to soils of the Miami series, they are intimately associated with them, occupying extensive level tracts between the ridged moraine areas and bordering on the undulating or nearly level till plains. It is natural that considerable areas in southern and southwestern Michigan should be formed by such deposits, since the drainage from the interlobate region between the Saginaw and the Erie lobes and between the Saginaw and Lake Michigan lobes escaped to the southwest across the Michigan-Indiana line. This condition also gave rise to extensive upland areas where the glacial deposits are so evi-

dently water washed as not to be included within the soils of the Miami series.

Another form of glacial deposits of less extent consists of the long, low, rounded hills, frequently elliptical in shape and made up chiefly of unstratified glacial material, which are known as drumlins. These hills usually occur in groups. The longer axes of the different ridges are as a rule approximately parallel, and the resulting topography is fluted and ridged with greater or less regularity. It is thought that these glacial forms were produced beneath the ice and that the direction of the longer axes marks in a general way the direction of ice flow. These hills are mainly covered by the unstratified glacial till, so that they are occupied generally by the same soils as the intervening till plains and the associated morainal ridges.

Along the southern and western margin of the region occupied by the soils of the Miami series and to some distance within its outer border the surface of the moraines and till plains alike is covered by a thin layer of distinctly silty, rather homogeneous and stone-free material. It is probable that this material originally was carried beyond the ice border in the form of fine sediment washed out by the water from the melting ice. It is also thought that it owes its present position over the uplands to the long-continued action of the wind, which, sweeping over silt-covered plains, carried large quantities of this fine earth over the upland, depositing it as a surface covering of varying depths over the moraines and till plains. Where this silty mantle, known as loess, attains a thickness of more than 3 feet, it gives rise to distinct soil types not included within the Miami series. In many cases it forms only a thin surface covering, as in large tracts in Indiana, Ohio, and Wisconsin, and in these localities the glacial till forms the deeper subsoil, the resulting soil type being classed as the Miami silt loam.

It is a common characteristic of all the materials which were mingled to form the moraines, the till plains, the drumlins, kames, and other forms of glacial drift, and which give rise to the soils of the Miami series, that the earthy mass and the included gravel and stone were derived from various sources along the path of the glacial invasion. It is probable that at the time of the latest stage of the Wisconsin glacial advance there were exposed extensive areas of the older drift sheets which mantled a large part of the region now covered by these later deposits. Numerous well borings and many exposures of the older drift in deeply cut stream channels show that it still exists and that the newer drift rests upon its surface throughout a great part of the general region of the Miami soils. Since it presented a soft, unconsolidated surface to the erosive action of the readvancing

ice, it is more than probable that a very large part of the earthy material which was reworked into the later till sheet was contributed by this older till and its associated sandy and gravelly deposits. Through this unconsolidated material the local country rock had been exposed by water erosion occurring between the different stages of glaciation. As the ice readvanced over the surface of the region it picked up earthy material from the older till, mingled it with earthy and stony material from the various rock outcrops, and contributed varying amounts of extraneous material carried into the region from the areas of crystalline rocks which were exposed to glacial action in the territory north and east of the Great Lakes.

It is probable that a large part of the material derived from local sources was carried under the ice and within its lower sections. There is considerable evidence that such local materials were moved only short distances and rearranged and deposited by the melting ice to form the deeper part of the surface till covering. For this reason the local country rock exerts a strong influence upon the lithological character of the till sheet, in some cases giving rise to 90 per cent or more of the coarser stony particles which may be identified.

Thus, the ice of the Wisconsin stage of glaciation in its advance collected material from the limestones and shales of western Ohio and central and eastern Indiana, from the limestones, shales, and sandstones of the lower peninsula of Michigan, and from the limestones and associated shales which cover large areas in southeastern Wisconsin. Even where the limestone rocks do not directly underlie areas now occupied by the soils of the Miami series, broad areas of limestone lay directly across the path of the advancing glacial ice, as in the neck of the Saginaw Bay region, and, from exposed outcrops, contributions of earthy and stony material were obtained. It is also probable that materials derived from the remaining deposits of previous glaciation contained a fair percentage of such calcareous material. In Plate II, figure 2, a part of a ledge of the limestone which underlies portions of the Miami soils is shown.

The soils of the Miami series contain varying quantities of limestone bowlders, gravel, and rock flour in nearly all areas where they are mapped. This is particularly true of the deeper subsoil, which it is presumed most nearly represents the materials existing on the surfaces over which the ice moved. Examinations of the deeper subsoils show a general calcareous condition below depths of 1 to 2 feet, especially in the areas surveyed in Ohio, Indiana, and Wisconsin. The presence of the limestone or calcareous shale in the drift is not nearly so marked in southern Michigan as in other regions dominated by the Miami soils, but analyses of the drift indicate that as much as 25 per cent of the material is of a calcareous nature over considerable areas.

On the other hand, the surface soils of the different types in the Miami series are distinctly lacking in lime to a depth of 1 foot or more. Whether this condition is due to the original deposition of earthy material lacking in lime or is the result of the lime having subsequently been removed is not known.

The textural character of the rock prevailing in the different regions where the soils of this series occur has some influence upon the texture of the resulting soils. Thus, in the region of western Ohio, eastern and central Indiana, and a large part of southeastern Wisconsin, the most extensive areas are occupied by the clay loam and silt loam members of the series. These regions are also characterized by the presence of extensive beds of limestone and shale. These rocks in their original condition consist of rather finely divided mineral particles. Under the influences of glaciation they gave rise to fine-grained rock powder, and this was extensively worked into the till sheet. Some coarser particles were present, giving the material a sandy texture, and the gravel and stone are merely large fragments of rock which were not completely ground down by ice action. In the Lower Peninsula of Michigan and along the western border of the area occupied by soils of this series in Wisconsin, sandstones were much more generally exposed, and the loam and fine sandy loam types are extensively developed. In some parts of these sections the material derived from sandstone is so abundant that types of the Coloma series are intricately associated with the soils of the Miami series.

The thickness of the sheet of glacial drift from which the soils of the Miami series are chiefly derived varies considerably in different sections. It is usually greatest within the interstream areas and least where erosion has cut the valleys of the major streams deeply into the till plains. The drift is naturally somewhat thinner along the outer margins of the different areas than within the main areas of glaciation. Over the greater part of the area covered by these soils the total thickness of the glacial drift is made up of the combined depths of the latest till sheet and of one or more layers of older drift, although this condition is not universal. For these reasons the depth of the drift varies from a few inches to more than 500 feet.

Along many of the major streams which flow to the south from the glaciated region, such as the Scioto, the Mad, and the Miami Rivers of Ohio and the Whitewater and White Rivers in Indiana, ledges of rock outcrop along the crests of the slopes from the upland to the stream valley. In other instances the rock, whether limestone, shale, or sandstone, is only exposed in patches along the bed of the stream or in the narrow gorges of tributary brooks. Such exposures are usually absent over a large part of the main areas of glaciation. Only a few exposures of bedrock occur in southern Michigan, and

they are by no means numerous in northwestern Ohio and northern Indiana. In eastern Wisconsin there are some clifflike outcrops of limestone where the deposits of drift are relatively thin and do not entirely cover the irregularities of the preglacial topography. They are most numerous to the east of the basin of Green Bay, from the center of the Door Peninsula southwestward beyond Fond du Lac. Ledges of limestone and sandstone are exposed also along the western margin of the glaciated area of southern Wisconsin, from the vicinity of Portage to Beloit, Wis. These mark the thin outer edge of the till sheet.

Within the main glaciated regions there are numerous small areas where the till sheet is only a few feet in thickness, and in some of these localities erosion has so far removed the surface covering that only the surface soils are derived directly from the till, while the deeper subsoils are formed from materials resulting from the partial weathering of the underlying rock. The total extent of these areas which are occupied by rock outcrop or by a thin veneer of glacial material over the local rock is so small that they are relatively unimportant.

It is probable that, taking the region as a whole, the depths of the different till sheets average as much as 150 feet and that the area in which the till covering is 100 feet or more in depth greatly exceeds that in which the average thickness is less than 100 feet. The depth of the later Wisconsin till alone varies from a few feet to more than 150 feet.

There is one other common characteristic of the majority of the areas in which the soils of the Miami series are extensively developed. Owing to the irregularities of surface configuration the region is one within which numerous large and small areas of ponded and obstructed drainage exist. In the regions of greatest variation in relief, such as in southern Michigan and eastern Wisconsin, there are numerous large and small lakes and many depressed areas which are either in a swampy condition or have remained poorly drained until within the time of human occupation. Even within the gently rolling to undulating region of western Ohio and central Indiana the hollows and extremely level areas were poorly drained in their natural condition. In all such localities there has been an accumulation of partially decayed organic matter which gives a distinctly black or very dark brown color to the surface soils. For this reason the surface of the broad region chiefly occupied by the lighter colored soils of the Miami series is frequently and repeatedly interrupted by large and small areas of these darker soils which have been correlated mainly with the soils of the Clyde series. Where such areas are of too small extent to be separated on the scale used

FIG. 1.—IRISH POTATOES ON THE MIAMI FINE SAND, COLUMBIA COUNTY, WIS.

[Yields of 150 to 175 bushels per acre are obtained.]

FIG. 2.—PASTURE LAND ON THE HILLY MIAMI GRAVELLY LOAM, WAUKESHA COUNTY, WIS.

[The rolling and hilly topography of this soil renders it somewhat unsuitable for tillage.]

FIG. 1.—DIVERSITY OF CROPS ON THE MIAMI FINE SANDY LOAM.

[Potatoes, cabbage, clover cut for seed, oat stubble, corn, and a hay field are shown in an area of less than 40 acres.]

FIG. 2.—APPLE ORCHARD ON THE MIAMI FINE SANDY LOAM IN THE MICHIGAN FRUIT BELT, NEAR GRAND RAPIDS, MICH.

[Note the rolling and rigid topography.]

in mapping the soils, some of them are included with areas of the Miami types. In other cases the surface covering of this dark-colored soil is too shallow to warrant the separation of such areas, and there are included within the limits of certain types of the Miami series small areas in which the surface soils are considerably darker than the average of the series. Such areas are in rather sharp contrast with the prevailing light-colored Miami surface soils, but are necessarily included with the more typical development.

The details of surface topography and drainage, of local variations in derivation and thickness of the soil-forming material, of degree of agricultural development, and of cropping systems can only be given in the detailed soil surveys of counties and other areas. From such surveys and from the examination of areas not yet covered by the soil survey the main characteristics of the different soils of the series are summarized.

TYPE DESCRIPTIONS.

MIAMI SAND.

The Miami sand is mapped in Waukesha County, Wis., over a total area of 1,920 acres. This type consists of a yellowish to brownish gray medium to fine sand 6 to 8 inches deep, underlain by a yellow, loose, incoherent sand of the same grade. The soil is very low in organic matter. Because of its loose, open structure it is easily cultivated, and can be worked under almost any moisture condition. Where the surface is not covered by a crop the sand is sometimes drifted by the wind, though not to any great extent.

Owing to the gently rolling to rolling topography, together with the loose, open character of the soil and subsoil, the drainage is excessive, and crops suffer from drought, except during seasons of unusually well distributed rainfall.

Practically all of the Miami sand is derived from glacial moraine material. The type was originally forested with a scrubby growth of bur oak, red oak, and white oak. At present hazel bushes cover a part of the type. The greater part of it is under cultivation, the principal crops being corn, oats, rye, and clover. When the rainfall is well distributed, fair yields are obtained. The land is not highly developed.

Soils like the Miami sand are better adapted to early truck crops than to general farming. For any crop it is necessary to increase the organic-matter content of the soil. This is best accomplished by frequently turning under green manuring crops and saving and applying all available stable manure.

MIAMI FINE SAND.

Areas of the Miami fine sand have been encountered only in Columbia and Jefferson Counties, Wis. The total area mapped thus far amounts to 47,296 acres.

The Miami fine sand consists of a light-brown, loose, incoherent fine sand, which is low in organic matter. At about 9 to 10 inches in depth the material is light yellow, becoming lighter in color with depth, until at 30 to 36 inches it is almost white. The till bed, consisting of a mixture of sand, gravel, silt, and bowlders, is encountered at depths of 4 to 6 feet. Small quantities of limestone gravel and bowlders occur on the surface and throughout the soil section, but are seldom sufficiently numerous to interfere with cultivation.

The type is subject to some variation. On the lower slopes and in depressions the surface is darker and contains a larger amount of organic matter than the typical soil. Such areas are slightly loamy and have a somewhat higher agricultural value than the remainder of the type. In a few places a sticky sand is encountered at depths of 30 to 36 inches. A few gravel beds are scattered throughout the type, and such deposits have only a shallow surface covering of soil. Exposed areas are sometimes wind drifted, small dunes being formed. In general the Miami fine sand is both coarser in texture and lower in agricultural value than the Miami fine sandy loam, with which it is closely associated.

The topography varies from gently rolling to rolling. The surface is sometimes broken by sand dunes and depressions, though rarely to such an extent as to render cultivation impracticable. Owing to the loose, open structure of the material and to the surface configuration, the natural drainage is excessive and the soil as a whole is droughty. There are a few kettle-shaped basins and dune depressions which are not connected with drainage channels, and even in these places the drainage is usually sufficient, owing to the sandy nature of the deeper subsoil. Except during the heaviest rains, storm waters are rapidly absorbed by the soil and danger from erosion through surface run-off is reduced to a minimum.

The type is largely of glacial origin, being derived from the weathering of the glacial till, somewhat modified by wind and stream action. The weathering of the limestone fragments in the underlying till has a tendency to correct any acidity existing in the soil material, though this is often counteracted by leaching, leaving the surface soil more or less acid.

The original forest growth consisted chiefly of white, red, and bur oak, with some hickory and hazel brush. All of the merchantable timber has been cut, but the scrubby growth of oak and hazel bushes has been allowed to remain on a few of the poorest areas of the type.

About 75 per cent of the Miami fine sand is under cultivation, while approximately 22 per cent remains in untilled pasture land. About 2 per cent consists of sand dunes and about 1 per cent of moraines, kettle basins, and land too stony and rough to be of any value except for pasture.

The general farm crops common to the region are grown. Corn under normal conditions averages 25 bushels to the acre, oats 22 bushels, rye 12 bushels, and timothy and clover about 1 ton. Potatoes yield as high as 150 to 175 bushels per acre where given special attention, though the average is lower than this for the entire type. A crop of potatoes on the Miami fine sand is shown in Plate III, figure 1. Beans, tobacco, and cucumbers are grown to a small extent.

No definite crop rotation is in general use on this type, but one which gives good results in some sections consists of corn, followed by oats one year, then by rye for one year with clover and timothy seeded for hay. The hay is usually cut for one year and the second year the land is pastured, after which it is plowed again for corn. Where manure is available it is usually applied to the sod. Green manuring is not practiced to any extent and commercial fertilizers are seldom used. Another rotation which has given success on similar sandy soils consists of potatoes, followed by a small grain such as rye or oats, and the land seeded to clover. The first crop of clover is usually cut for hay and the second plowed under for green manuring. If sufficient manure is available the second crop of clover may be left for seed. Corn may be grown in the place of potatoes if desired. Where the soil conditions are made favorable, alfalfa may be successfully grown on this soil, though it is more difficult to secure and maintain a good stand than on a heavier soil. The production of truck crops is profitable on this type, especially near shipping points or home markets.

Owing to its loose, open structure, this soil is easily cultivated, and under good methods of farming the productiveness of the type gradually increases. The methods now followed over a large part of the type, however, are not such as tend to bring about this result. The lack of organic matter in the soil and its low water-holding capacity are best corrected by the use of stable manure and green manuring crops.

MIAMI GRAVELLY LOAM.

The Miami gravelly loam has been mapped over a total area of 45,184 acres in Fond du Lac County, Wis., and 192 acres in Auglaize County, Ohio.

The surface soil consists of a light-brown silty loam, having an average depth of about 8 inches. The subsoil to a depth of 2 or 3

feet is a brown or yellowish-brown silty clay loam, which is in most cases underlain by a heterogeneous mixture of sand, gravel, clay, and bowlders. Gravel and bowlders in varying quantities are also scattered over the surface and mixed with both soil and subsoil. In some cases the type occurs over small hills, and in such positions it is underlain at shallow depths by limestone.

The topography varies considerably, although over most of the areas it is rolling to hilly. On the steeper slopes it is necessary to leave this type in grass or in forest in order to prevent erosion. These features are shown in Plate III, figure 2. The natural drainage of the type is good, and in places where the gravel beds or the underlying rocks are near the surface it is excessive, causing the soil to be droughty in years of light rainfall.

The Miami gravelly loam is derived from glacial till, or partially reworked glacial till occurring in the form of glacial moraines, kames, and eskers. In some places where the covering of glacial material is shallow the underlying rock has contributed limestone fragments, at least to the lower subsoil.

The type was originally forested with a growth consisting chiefly of maple and oak, with some hickory.

Where the soil and subsoil have a total depth of 24 inches or more and where the surface slopes are not too steep, fair average yields are produced during seasons of normal rainfall. Where the surface covering is less than 2 feet either over the gravel or the underlying limestone, crop yields are low, and such areas are of greater value for grazing than for the production of cultivated crops. Corn, oats, barley, and mixed hay are the chief crops on the tilled areas. The rougher areas are utilized chiefly for permanent pasture and farm woodlots. Not over one-half of the type is used for crop production.

MIAMI GRAVELLY SANDY LOAM.

The Miami gravelly sandy loam has a total area of 66,944 acres in Jefferson and Waukesha Counties, Wis.

The surface soil of this type, extending to a depth of 8 to 10 inches, consists of a light-brown sandy loam. Where typically developed the soil is friable and rather loose. Varying quantities of gravel and numerous bowlders are found in the surface soil. The larger bowlders are usually removed from cultivated areas. The subsoil to a depth of about 2 feet is a reddish-brown or yellowish-brown gritty clay loam. This is generally underlain by a mass of gravel, cobblestones, and bowlders. The stony material largely consists of limestone.

The topography of the Miami gravelly sandy loam ranges from rolling to ridged and hilly. The material is derived chiefly from

moraine and kame areas of glacial origin in which the underlying beds of gravel and bowlders are covered with a thin surface deposit of till. The drainage of the type is good to excessive. The steeper slopes are frequently subjected to erosion and are unfavorable for tilled crops. The more gently rolling and sloping areas, where the depth of soil and subsoil is 2 feet or more, retain sufficient moisture to mature good crops in seasons of average rainfall.

About one-half of the total area of the Miami gravelly sandy loam is under cultivation. The remainder of the type is occupied about equally by permanent pasture, consisting chiefly of bluegrass and white clover, and by farm woodlots or small tracts of forest.

The cultivated areas of the Miami gravelly sandy loam are devoted to mixed general farming, including the production of corn, oats, rye, and hay, and the raising of dairy cattle and hogs. Corn yields from 25 to 40 bushels per acre. It is not so extensively grown upon the Miami gravelly sandy loam as upon the heavier members of this series with which this type is associated. Oats constitute the chief small grain crop, giving yields of 25 to 40 bushels per acre. A small acreage of rye is grown, yielding 15 to 25 bushels per acre. Wheat and barley are grown to a small extent. The hay crop generally consists of mixed timothy and clover, and yields of about 1½ tons per acre are secured. Alfalfa is quite extensively grown on this type and is usually successful. Owing to the excellent drainage of this type and the large amount of lime carbonate in the soil, it is well adapted to alfalfa where the total depth of soil and subsoil over the underlying bowlders and gravel is 2 feet or more. This crop is not usually successful on the crests of hills and along eroded slopes where the underlying stony material is near the surface.

The Miami gravelly sandy loam is usually associated with other types of the Miami series which are somewhat better suited to the growing of corn and oats, and there is a tendency to leave this rougher and more stony land in permanent pasture. It is capable of supporting a good sod of bluegrass and white clover, and with but little attention produces good pasturage.

MIAMI SANDY LOAM.

The Miami sandy loam has thus far been encountered in only two small areas. It occupies a total of 5,440 acres in Genesee County, Mich., and a total of 1,280 acres in Fond du Lac County, Wis.

The surface soil of the Miami sandy loam has an average depth of about 10 inches, and consists of a yellowish-gray to brown sandy loam. The subsoil to a depth of 3 feet or more is a light-yellow sandy loam. This is underlain by the sandy clay or clay which

constitutes the deeper till of the region. Gravel in varying quantities is found in both the soil and subsoil and is frequently scattered over the surface.

The topography of this type varies from undulating to hilly, and the natural drainage is good. During dry seasons crops suffer somewhat from drought.

Corn yields from 15 to 30 bushels an acre, with an average of about 20 bushels. Oats yield from 25 to 50 bushels, and rye averages about 15 bushels per acre. Timothy and clover are grown for hay, producing from 1 to 2 tons per acre. Irish potatoes are grown to some extent, the yields ranging from 100 to 200 bushels per acre. Small areas of beans and buckwheat are grown.

MIAMI FINE SANDY LOAM.

The Miami fine sandy loam is one of the more important and extensive members of the series. It has been mapped over a total of 281,664 acres. The principal areas thus far encountered are in the eastern and southern sections of the lower peninsula of Michigan and in the southeastern part of Wisconsin. It is probable that other areas of this type are developed in adjoining sections of these two States and in the northern part of Indiana.

The soil of the Miami fine sandy loam to an average depth of about 8 inches is a light-brown to grayish-brown medium to fine sandy loam. The color varies somewhat in different areas of the type. There is usually a tendency toward a yellowish-brown color at the surface on ridges or in other positions exposed to erosion, while the color is darker in the more nearly level areas and on the lower slopes where organic matter has accumulated to a considerable extent in the surface soil. The subsoil to an average depth of about 2 feet is a brown or yellowish-brown loam, usually containing a large amount of fine sand. This grades through a sticky sandy loam into a heavy clay loam or clay which is usually encountered at a depth of 3 feet or more. A small quantity of gravel is commonly present in the surface soil, and in greater amounts in the deeper subsoil, which also generally contains cobblestones and bowlders. In some localities bowlders are scattered over the surface of this type, although the majority of these have been removed and used in the construction of fences or the foundations of farm buildings. The gravel and other stones of smaller size, particularly in the deeper subsoil, consist largely of local limestone rock. The larger bowlders, especially those scattered over the surface, are usually crystalline rocks brought to the region through the agency of glaciation. In some instances, where the covering of glacial material is thin, limestone rock is encountered at a depth of 3 to 5 feet.

The surface configuration of the Miami fine sandy loam varies widely. The type generally occupies the rolling to hilly upland areas which mark the location of old glacial moraines. The topography ranges from rolling to ridged, with many small intervening depressions and inclosed basins between the ridges. The Miami fine sandy loam is comparatively thin over the ridges, frequently becoming thicker along the lower slopes and in the more nearly level areas. It is particularly well developed in the rolling to hilly belt which extends from the "thumb" of Michigan southwestward to the Ohio-Indiana State line. It also covers portions of the low moraines in central Michigan, from the vicinity of Lansing west and north nearly to the shore of Lake Michigan.

In south-central Wisconsin the topography of the Miami fine sandy loam is generally undulating to rolling. The type occupies low morainal ridges, undulating till plains, and some nearly level marginal areas. In extreme northern Wisconsin a large area of the type found in Marinette County is nearly level to only slightly undulating.

In general, the natural drainage of the Miami fine sandy loam is good. Where the depth of the surface sandy material is 2 feet or more, especially if the surface slopes are at all steep, there is a tendency toward droughty conditions. This is also true on the narrow crests of morainal ridges and in other places where erosion has exposed the underlying gravelly or stony material. These areas, however, are of comparatively small extent and over the greater part of the type the texture and depth are favorable to the absorption and retention of sufficient moisture for the production of the staple crops of the region. Some of the small, depressed, kettle-shaped areas of the type are rather poorly drained and are subject to the accumulation of drainage and seepage waters from higher areas of the type. These are the only areas in which the need for artificial drainage is great.

The Miami fine sandy loam has been formed by the weathering of glacial till. It is probable that the surface material has been assorted and modified to some extent through the melting of glacial ice, but in almost all instances the deeper subsoil consists of unmodified glacial till. This material has accumulated in long, irregular ranges of morainal hills, in low, undulating swells, and in the form of nearly level but somewhat irregular, dimpled till plains. The material entering into the composition of the Miami fine sandy loam consists largely of the local country rock, which in a majority of cases comprises limestone, sandstone, and shale mingled with a varying amount of the débris of crystalline rocks brought to the region during the period of glaciation. It is a common characteristic of the type that a large part of the finer gravel and even some of the coarser

sandy material consists of local limestone or calcareous shale. Usually this lime-bearing material is distributed through the surface soil and upper subsoil in small quantities, becoming predominant only in the deeper subsoil. As a result, the surface soil of the Miami fine sandy loam is frequently slightly acid, while the subsoil commonly contains sufficient lime carbonate to effervesce when treated with acid.

The greater part of the Miami fine sandy loam thus far encountered in soil-survey work occurs in areas which have been used for agriculture for a long period of time, and from two-thirds to three-fourths of the area of the type in these localities is cleared and cultivated. It is only in the northern part of Wisconsin that any considerable area of the type remains to be utilized. The more rolling and thinner portions of the Miami fine sandy loam have been left in forests or permitted to grow up to scrubby timber. These and small areas which are either too steep for tillage or too poorly drained constitute the only parts of the type which are not used for farm crops.

The form of agriculture commonly practiced on the Miami fine sandy loam consists of mixed general farming, usually supplemented by dairying, hog raising, and the fattening of a few beef cattle.

Corn is the chief intertilled crop grown on this soil. It is usually planted upon sod, and applications of stable manure are commonly made. The yields range from 15 to 40 bushels per acre with a general average of about 30 bushels under ordinary seasonal conditions. The yield of corn on the deep sandy areas of the Miami fine sandy loam is usually less than on the typical areas of this soil. The Miami fine sandy loam is somewhat too porous and sandy to constitute an ideal corn soil, although the free use of stable manure and of other organic fertilizers such as clover sod and green manuring crops enable the farmers upon this type to produce fair average yields. Oats constitute the chief small-grain crop grown upon the Miami fine sandy loam. The corn stubble is usually plowed in the fall or early spring and the seeding to oats is made as early in the season as possible. Under conditions of normal rainfall oats yield from 25 to 50 bushels per acre, with an average for a long period of years of about 35 bushels. It is a common practice to seed mixed timothy and red clover or mixed red clover and alsike with the oats. In this case the land remains in hay for one or two years. The oat stubble is sometimes plowed for a succeeding crop of wheat, but this practice is no longer popular, as the yield of wheat on this soil ranges from 10 to 20 bushels per acre, with an average of not more than 14 bushels. Wheat production upon the Miami fine sandy loam is decreasing. In some localities the growing of rye has taken the

FIG. 1.—PEACH ORCHARD ON THE MIAMI FINE SANDY LÔAM IN THE MICHIGAN FRUIT BELT, NEAR GRAND RAPIDS, MICH.

FIG. 2.—AN EXTENSIVE CHERRY ORCHARD ON THE MIAMI FINE SANDY LOAM.

FIG. 1.—CONCORD GRAPES ON THE MIAMI FINE SANDY LOAM IN WESTERN MICHIGAN.

[A large apple orchard is shown in the background.]

FIG. 2.—A GOOD YIELD OF WHITE DENT CORN ON MIAMI LOAM IN SOUTHERN MICHIGAN.

[A part of the corn is husked in the field and a part is cut into the silo shown in the background.]

place of wheat in the rotation, and yields of 15 to 25 bushels, with an average of about 18 bushels per acre are secured.

Barley is probably more extensively grown on the Miami fine sandy loam than any other small grain except oats. Yields of 20 to 30 bushels per acre are secured, and the grain is of excellent quality. Both rye and barley do better than wheat on this type.

The area devoted to hay production varies widely in the different sections where the Miami fine sandy loam is encountered. In southeastern Michigan probably one-third of the total area of the type produces some form of hay. Timothy and clover are most commonly seeded, especially on the dairy and stock farms. In such cases the hay is cut for one or two years, and the mowing land is then pastured for one year before being plowed for corn or some other intertilled crop. Where red clover is seeded alone the first crop is usually cut for hay and the second crop matured for seed. The yields of hay are good on all the type except the most sandy or the eroded areas. Yields of 1½ to 2 tons of mixed hay per acre are common. The yield of clover is usually about the same. In addition to the portion of the mowing land which is annually pastured, a large part of the more rolling areas of the Miami fine sandy loam is in permanent pasture. This natural pasture consists largely of Canada bluegrass (June grass) and white clover. It usually constitutes good pasturage during the early part of the season, but has a tendency to become dry and unpalatable in mid-summer.

Beans constitute a cash crop quite generally grown on the Miami fine sandy loam in southern and southeastern Michigan. The crop is planted either on sod land or following corn. The common navy bean is most extensively grown, the yields ranging from 12 to 20 bushels per acre, with a general average of about 15 bushels. The beans are thrashed and sold to the cleaner, while the bean straw and refuse beans are commonly fed to sheep.

Early Irish potatoes constitute another special crop of importance on the Miami fine sandy loam. It is the usual practice to plant the potato crop on sod land, clover sod being preferred. The yields secured range from 60 to 150 bushels per acre, with an average of about 100 bushels. Growers who are particularly careful with the cultivation and fertilization of the crop easily exceed this average. Potatoes are commonly grown in small patches chiefly for home use, with a small surplus for market. In some parts of southern Wisconsin, however, they constitute the chief cash crop on the Miami fine sandy loam. The field shown in Plate IV, figure 1, indicates the diversity of crops grown on this soil.

Throughout southern Michigan, and to a less extent in southern Wisconsin, on nearly every farm located on or containing a con-

siderable area of the Miami fine sandy loam a small family apple orchard is grown on this soil. Nearly all of the standard varieties are grown. The Baldwin, Duchess, Wealthy, and Wagener, are the most popular varieties in these small orchards.

The Miami fine sandy loam occurs quite extensively upon the hills and rolling ridges of the Michigan fruit belt along the eastern side of Lake Michigan. It is utilized extensively for commercial orcharding, and many varieties of apples are grown successfully. It is the best soil used for the production of the Baldwin apple. Wherever the heavier subsoil is near the surface the type is well adapted to the growing of the Spy. The other varieties grown upon this type in commercial orchards are the Wealthy, Wagener, and Shiawassee, together with subordinate varieties such as the Chenango, Maiden Blush, and Snow. The Jonathan is also grown. Apple trees on the Miami fine sandy loam are shown in Plate IV, figure 2.

Where local climatic conditions are favorable, as in the Michigan fruit belt, peaches constitute an excellent orchard crop on this type. The Elberta is the principal variety, although the Crawford and Lewis are also grown. Peach trees on this type are shown in Plate V, figure 1.

In some localities, particularly in the Traverse Bay region, the growing of cherries on the Miami fine sandy loam has become an important industry. The Montmorency, Ordinaire, Morello, and Richmond varieties are chiefly grown. A mature cherry orchard on the Miami fine sandy loam is shown in Plate V, figure 2.

In some localities grapes are successfully grown upon the Miami fine sandy loam. The Concord is the most common variety. A typical vineyard is shown in Plate VI, figure 1.

In general, the Miami fine sandy loam is well suited to orcharding and fruit growing wherever climatic conditions are favorable, and especially upon the gently rolling or slightly hilly portions of the type which are favored by good air and water drainage.

In southern and southeastern Michigan, and to a less extent in southwestern Wisconsin, dairying is an important industry on the Miami fine sandy loam. A large part of the corn grown upon this soil is cut for the silo, and this, together with the hay grown upon the farm, constitutes the chief winter feed of the cattle. The herds are usually small, averaging 10 or 12 cows to the farm, and grade animals of the different dairy breeds are commonly kept. A few farmers on this type fatten beef cattle during the winter. The raising and fattening of hogs is practiced on many of the farms. Where beans are an important crop, some sheep are kept and fed on the bean straw and other forage.

The Miami fine sandy loam constitutes a fairly good general farming soil, giving average yields of the staple crops under normal climatic conditions. It is well suited to the growing of beans and Irish potatoes. Where the climate is favorable it is used extensively for fruit production. Locally this type supports the dairy and other livestock industries. There is a general appearance of prosperity about the farms located on this soil; the farm buildings are usually well built and in good repair, and include, in addition to the dwelling house, large barns and outhouses for the storage of hay and grains and for the housing of stock. In the dairy section of southern Michigan silos are found on practically every farm.

MIAMI LOAM.

The Miami loam has been encountered in 15 different soil surveys located in southern Michigan, northeastern Illinois, and southeastern Wisconsin. A total area of 714,614 acres of this type has been mapped. It is probable that additional areas of considerable extent will be encountered as the soil survey work is extended in this general region.

The soil of the Miami loam to an average depth of about 10 inches is a soft, friable loam of a brown or grayish-brown color. When dry the surface of a plowed field is light gray or ashy gray, while in depressions or other locations where organic matter has accumulated the color is dark gray to brown. In the more rolling areas of the type the color is usually light brown or yellowish brown. When moist the surface material is uniformly somewhat darker. Usually small quantities of gravel and in some localities a few bowlders are scattered over the surface. Some gravel is encountered in the surface soil. One phase of the type, occurring in hilly areas, is decidedly stony, but this constitutes only a small part of the area mapped.

The subsoil of the Miami loam to a depth of 2 feet or more is characteristically a yellowish-brown heavy loam or clay loam, which contains an appreciable amount of coarse sand and fine gravel and is usually somewhat gritty. This grades downward into a compact gritty clay which contains large quantities of gravel and bowlders of various sizes. The color of the deeper subsoil varies, but is usually brown or gray, or shows mottlings of these colors.

Throughout southeastern Wisconsin and northeastern Illinois a large part of the coarser sand and gravel, and many of the bowlders, consist of limestone of local derivation, and the deeper subsoil is consequently calcareous. In southern Michigan the limestone is not so abundant, but it is estimated that approximately 25 per cent of

the material of the deeper subsoil is derived from calcareous rocks. In Michigan a much larger proportion of granites, schists, and other crystalline rocks has been mixed with the soil-forming material.

Field determinations indicate that the surface soil of the Miami loam is generally acid to a depth of 9 to 12 inches, even where the subsoil contains large quantities of limestone fragments.

All of the areas of the Miami loam thus far mapped are derived from the broad till plains and rolling morainic areas of glacial drift formed during the last stage of the Wisconsin ice invasion. While a large part of the material entering into the composition of the soil is derived from the local rock of each region where it is mapped, there has been added a varying amount of material brought by the glacial ice from distant localities. The crystalline rocks in the form of bowlders and gravel are of such origin, and it is probable that a large part of the finer-grained material of the soil and subsoil was similarly contributed. Consequently the Miami loam consists of a heterogenous mixture of mineral matter from a wide variety of rocks, and it is partly due to this fact that this soil is highly productive and durable under continued cultivation.

All of this derivative material was brought to its present position by the glacial ice which overspread the region. It was deposited as a thick sheet of till over the more nearly level areas, and accumulated in ridged and hilly tracts where the front of the ice stood temporarily during the retreat of the glacier. Usually such areas are marked by accumulations of bowlders at the surface and within the soil and subsoil, while occasional gravel beds and some sand occur in the deeper subsoil. Over the till plains the entire mass is a rather uniform compact, gritty, and gravelly bowlder clay.

The topography of the greater part of the Miami loam is undulating to gently rolling. There are large areas within which the surface is hilly or ridged and where the elevations rise 75 to 100 feet above the general level of the upland. These ridged areas are interspersed by large and small kettle-shaped depressions, so that the surface is decidedly irregular. Such areas are encountered where the type occurs on the morainal ridges. In southeastern Wisconsin the type is gently undulating to rolling. It occurs to some extent as long, low, gently sloping ridges, with large areas of nearly level land intervening. In general, there is sufficient slope to insure good surface drainage over the type, although in the more nearly level tracts and in local depressions the installation of tile underdrains is beneficial.

Probably over three-fourths of the total area of the Miami loam encountered in the progress of soil-survey work is under cultivation. The remainder of the type consists of broken or hilly tracts which are either forested or are utilized as permanent pasture. The type

is highly esteemed for farming, and wherever the topography is favorable it is regularly cropped.

Corn is extensively grown upon the Miami loam in all of the areas mapped except in Kewaunee County, Wis., where the acreage is somewhat restricted by a normally short growing season. Elsewhere corn is the chief intertilled crop. The dent varieties are principally grown, although some flint corn is produced in the more northern localities. Under average seasonal conditions corn yields from 30 to 50 bushels per acre, depending upon the degree of care exercised in the preparation of the land and the tillage of the crop. The general average for the type is probably about 40 bushels per acre. A large part of the corn crop is harvested for the grain, although there is an increasing tendency to use it for silage. Where grown for silage the yields secured range from about 10 tons to as high as 15 or 16 tons per acre. In the dairy districts this use of the crop is becoming general. A corn field on the Miami loam is shown in Plate VI, figure 2.

The oat crop occupies the largest area among the small grains. Oats are commonly sown following corn in the rotation. The yields obtained range from 30 to 50 bushels per acre under ordinary conditions, although a production of 75 bushels per acre has been obtained. A large part of this crop is usually fed on the farm, but a portion is sold in some localities. The straw is usually fed or used for bedding. A field of oats on the Miami loam is shown in Plate VII, figure 1.

Winter wheat is grown on the Miami loam to a small extent in southern Michigan, giving yields of 12 to 30 bushels per acre, with a general average of something less than 18 bushels. The acreage is steadily decreasing. In southeastern Wisconsin barley constitutes an important crop on this soil, and yields of 25 to 30 bushels per acre are commonly obtained. It is probable that the average yield for the type is in the neighborhood of 25 bushels. Rye and buckwheat are also grown to some extent, giving fair average yields.

Hay is produced over an extensive acreage on this soil. The most common hay crop consists of a mixture of timothy and clover, although in some cases clover is seeded alone. The yields obtained range from 1½ tons to 2 tons per acre. Where clover is seeded alone it is a common practice to cut the first crop for hay and to mature seed from the second crop. In some localities in Michigan and more generally in southeastern Wisconsin the growing of alfalfa upon the Miami loam has been tried. It is a successful crop over a large part of the type, producing 2½ to 5 tons per acre. It is considered advisable to apply ground limestone at the rate of 1 or 2 tons per acre and to inoculate the alfalfa fields. It is also essential

that the land be well drained in both the soil and subsoil. There has been a considerable increase in the acreage of this crop on the Miami loam during the past few years, chiefly on the dairy farms of southern Michigan and in the southeastern counties of Wisconsin.

Several special crops are grown to some extent upon the Miami loam. It is probable that the acreage of beans is largest among these crops in southern Michigan. The navy beans are grown, giving yields of 12 to 30 bushels per acre, with an average of about 20 bushels. Plate VII, figure 2, shows a good field of beans on this type. In localities near sugar factories some sugar beets are produced on the Miami loam. The yields range from 7 to 12 tons per acre, and the quality of the beets is good. The areas of the type which are well supplied with organic matter are better suited to this crop than the lighter colored areas.

Nearly every farm upon the type produces sufficient potatoes for home use, but the crop is not grown on a commercial scale to any extent. The yields range from 65 to 150 bushels per acre, the average being about 100 bushels per acre. The type is well adapted to the commercial production of this crop.

Under favorable climatic conditions the Miami loam is fairly well suited to the production of fall and winter varieties of apples. Many farms include small orchards of standard varieties which supply home needs. In southwestern Michigan the more rolling areas of the type are utilized for commercial orchards. Peaches also are grown successfully near the shore of Lake Michigan on the Miami loam. Recently grapes have been grown with success on this type in Cass County, Mich. The more rolling areas of the Miami loam, possessing good soil and air drainage, are available for orchard development, especially within the section of southwestern Michigan, where the climate is most favorable owing to the proximity of the lake.

The dairy industry constitutes an important branch of farming upon the Miami loam. In all areas where it has been encountered the chief use of the hay and grain crops is for feeding to dairy cattle. A good dairy herd is shown in Plate VIII, figure 1. The milk produced is either sold to city markets or made into butter or cheese at local factories. In some localities beef cattle are fattened from the products of this soil. Hogs are generally raised in connection with the dairy and beef cattle industries, and large numbers are marketed each year. Some sheep are kept, especially in the section where beans constitute a staple crop, the bean straw and cull beans being used for feed.

In general the farms on the Miami loam present an appearance of prosperity. The farm buildings are well built and well maintained. On the average dairy or stock-feeding farm the buildings

consist of a good farm house, large dairy and stock barns, and usually one or more silos for the storage of the corn crop. Such a group is shown in Plate VIII, figure 2. The work stock is quite generally of good quality and of sufficient weight to accomplish the tillage of this soil. A large part of the farm work is done by the use of horsepower machinery.

Tile underdrainage has been installed only to a small extent in this soil. The larger part of the type is fairly well drained in its natural condition, but the more nearly level areas, especially where the subsoil is compact, heavy clay loam, are materially benefited by the use of tile. The yields of all crops are increased, while the profitable production of alfalfa and even of red clover depends to a considerable degree upon the use of tile drains to improve the drainage of the subsoil.

The crop rotations upon the different areas of the Miami loam vary considerably. The general practice is to plow sod land for the growing of corn. The next year the land is seeded to oats. This crop is usually followed either by wheat or barley, and a seeding to mixed timothy and red clover or to clover alone is made with the second grain crop. The land is allowed to remain in hay for two or more years. It may be pastured the last year in sod. Potatoes, beans, sugar beets, or other intertilled crops are usually planted on sod land, although the local practice varies somewhat.

Little commercial fertilizer is used upon the Miami loam. The cheaper grades, rather high in phosphoric acid, are used for wheat to some extent. The stable manure produced upon the farm is commonly applied to the land to be plowed for corn. Some farmers use the manure as a top dressing on the grass land the second year after seeding. Practically no use of green manuring crops is made, and the stable manure and the sod, which is turned under for the corn crop, are depended upon for the maintenance of organic matter in this soil. A field in which clover sod is being plowed under is shown in Plate IX, figure 1. It is probable that considerable improvement in the condition of the more sloping areas of this type could be effected through the use of winter cover crops, to be turned under to increase the organic matter in the surface soil.

Although the subsoil of the Miami loam is generally well supplied with lime, it has been found profitable to apply lime to the surface soil when seeding to clover or alfalfa. Usually 1,000 to 1,500 pounds of quicklime or 1 to 1½ tons of ground limestone per acre is sufficient to put the surface soil in good condition for the growing of the leguminous crops.

Practically all of the Miami loam which is not too steep or stony for cultivation is utilized for cropping. The type may be classed as a very good general farming soil, upon which corn, oats, wheat,

barley, and hay produce yields in excess of the general average for the different regions in which the type is found. Special crops are grown to some extent in different localities. Of these beans and sugar beets are most important, while nearly every farm on the type annually produces enough potatoes for the home supply. This crop might be more extensively grown to advantage. Rye and buckwheat produce fair yields, but are not grown extensively.

The crops produced upon the Miami loam are largely fed to dairy and beef cattle and to hogs and sheep. The wheat and some of the oats and barley are sold. The sale of surplus hay is an important source of income in some localities. The farms are generally well improved, well stocked, and maintained in a good state of productiveness. Under favorable conditions of climate and drainage it is possible to utilize this soil for the growing of the standard varieties of apples and for the production of peaches and grapes.

MIAMI SILT LOAM.

The Miami silt loam is an important and extensive soil type which has been encountered chiefly in central Indiana, northeastern Illinois, and southeastern Wisconsin. It has been mapped in 11 soil survey areas, occupying a total of 1,230,116 acres. It is known to occur in areas of considerable size in adjoining regions.

The different areas of the Miami silt loam vary somewhat in color, topography, and drainage. Some of these variations are of sufficient effect upon the cropping value of the soil and upon the methods by which it may best be tilled and managed to warrant the separation of two phases of the type, in addition to its normal development. The typical soil is the most extensive and important, but the flat phase and the deep phase occupy large areas.

The Miami silt loam consists normally of a dark-gray or light-brown, friable silty loam having an average depth of about 10 inches. The surface soil is usually somewhat deeper over level or depressed areas and shallower on steep slopes and over the crests of ridges. When moist the surface color is almost uniformly a grayish or yellowish brown, but when thoroughly dry it becomes a light or ashy gray.

The immediate subsoil to a depth varying from 20 to 30 inches is a yellow or yellowish-brown silty clay loam. This is underlain by a yellowish-brown or brown, gritty or sandy clay, usually containing an appreciable amount of coarse sand, gravel, and bowlders. As a rule this stony material consists chiefly of limestone, although crystalline erratics of various kinds form a part of the coarser grained material.

A scattering of gravel and some cobblestones are encountered on the ridges and knolls occurring within the Miami silt loam, and in some

FIG. 1.—OATS ON MIAMI LOAM NEAR WAUKESHA, WIS.

[Note the rolling surface of the country.]

FIG. 2.—BEANS ON THE MIAMI LOAM IN GENESEE COUNTY, MICH.

[The farm buildings are typical of the region.]

FIG. 1.—A PUREBRED DAIRY HERD ON THE MIAMI LOAM IN SOUTHERN WISCONSIN.

FIG. 2.—CHARACTERISTIC FARM BUILDINGS ON A DAIRY FARM IN SOUTHERN MICHIGAN, NEAR FLINT, GENESEE COUNTY.

FIG. 1.—PLOWING UNDER SECOND GROWTH OF CLOVER TO ADD ORGANIC MATTER TO THE SOIL, SOUTHERN WISCONSIN.

FIG. 2.—UNDULATING TILL PLAINS OCCUPIED BY MIAMI SILT LOAM, DEEP PHASE, IN JEFFERSON COUNTY, WIS.

FIG. 1.—HERD OF BEEF CATTLE ON MIAMI SILT LOAM.

FIG. 2.—REPRESENTATIVE FIELD OF CORN ON MIAMI SILT LOAM IN SOUTHERN WISCONSIN.

localities bowlders were numerous until removed from the fields and used for the construction of foundations of farm buildings. The stony areas are not usually extensive. On steep slopes within the type erosion has sometimes exposed the deeper subsoil, and gravelly and stony patches are found.

The topography of the greater part of the Miami silt loam is gently rolling to ridged and hilly. The type also occupies smaller tracts which are merely undulating or nearly level. The range in elevation within the limits of the type is greater in the southeastern part of Wisconsin than elsewhere, differences in elevation of 100 to 200 feet being encountered in the majority of the areas, with an extreme range of 500 feet or more. The type in this region occupies the tops and slopes of ridges, and the gently rolling or undulating till plains between the more pronounced glacial ridges. The undulating surface of such areas of the type is shown in Plate IX, figure 2. In central Indiana the differences in elevation are not so great. The elevation ranges from 50 to 150 feet, and a larger part of the type is marked by a low, undulating surface whose extreme elevations are not more than 25 to 50 feet above the general level. It is only along the courses of the larger streams, where erosion has modified the original surface, that steep slopes or considerable differences in elevation are found in this section. The greater part of all the areas mapped is best described as gently rolling or undulating, with a smaller part either nearly level or distinctly ridged.

Because of this moderate relief and of the generally sloping surface of the Miami silt loam it is commonly well drained in its natural condition. The presence of the gravelly and stony deeper subsoil also aids in subsurface drainage of the type. It was usually sufficiently well drained and elevated to be selected by the early settlers in the different regions. In some localities the low ridges included within areas of this soil were the only available sites for homes in pioneer days.

The entire type was originally forested, mainly with sugar maple, beech, hickory, oak of several species, some walnut, and a small amount of elm and ash. Nearly all of this original growth has been removed, and only the steeper and more hilly or stony areas remain in forest or farm woodlots. In some sections more than 95 per cent of the type is under cultivation, while it is probable that 80 per cent of the total area of this soil is used for some form of crop production. The remainder consists of pasture land and woodlots.

In all the regions in which it is developed the Miami silt loam has been esteemed as a productive general farming soil since its first occupation. In its forested condition a fair amount of organic matter accumulated in the surface soil, and it was usually well drained.

The timber growth furnished materials for the construction of farm buildings. The associated prairie lands were usually either poorly drained or covered with a tough sod which was difficult to break and convert into tilled fields. Wheat and corn were the crops first produced, and these are still important crops upon this soil. At one time it was found that the yields of wheat were decreasing, because of the practice of continuous cropping to this grain, and, probably, because of the exhaustion of a part of the original supply of organic matter in the surface soil. Definite crop rotations were introduced, and corn assumed considerable importance. At present a decidedly diversified type of general farming is commonly practiced on the Miami silt loam, while in southeastern Wisconsin the dairy industry occupies a prominent place upon it. In Indiana dairying is usually subordinate to the growing of grain crops, and to the fattening of beef cattle and the production of pork. A good herd of beef cattle is shown in Plate X, figure 1.

Corn is produced on practically all areas of the type. The yellow dent varieties are generally grown, although the white dent corn is also popular. Little flint corn is grown, as the growing season is sufficiently long to permit the production of the heavier yielding dent varieties. A representative field of corn on the Miami silt loam is shown in Plate X, figure 2.

The greater part of the corn harvested from this type is husked and shelled for the grain. Yields vary in different seasons and with different methods of cultivation, but a production of 40 to 60 bushels of corn per acre is not unusual, while yields of as much as 75 bushels per acre are obtained under favorable circumstances. The general average production is probably about 40 bushels per acre. A large part of the corn crop is annually cut into the silo, especially in the dairy district of southeastern Wisconsin, and upon those farms in Indiana where the fattening of beef cattle forms a part of the farm system. This is shown in plate XI, figure 1. The practice is increasing in popularity. Yields of silage range from 10 to 15 tons per acre, with an average of about 12 tons. All the better drained areas of the type which are fairly well supplied with organic matter produce good average yields of corn, although the yields obtained are usually below those secured upon the "black land" of the Clyde series associated with the Miami silt loam in many localities. In general, the largest yields of corn are secured where a regular rotation of crops is observed and where the corn is planted upon a clover sod or upon a timothy and clover sod. On the dairy and stock farms, where such rotations are practiced, and where a considerable amount of stable manure is also used upon the corn land, the yields of corn are above the general average for the locality. The tile underdrainage of this type in the more nearly level areas increases the certainty of

securing a good stand of corn and improves the yields. In many cases corn is planted for two or three years in succession upon the same field, but it is generally recognized that better results are obtained where it is only grown for a single year upon sod ground and followed in regular rotation by small grains and grass.

Among the small grains oats are most extensively grown, particularly in the more northern localities. The crop is sown upon corn-stubble land. Such land is usually plowed for the oat crop, but may be prepared by disk harrowing without plowing. The yields obtained range from 35 or 40 bushels to as high as 65 bushels per acre. The general average for the type is probably about 40 bushels per acre. A large part of the grain is fed on the farm, and the straw is used for feed and bedding. In some localities a small part of the grain is marketed.

Winter wheat also occupies an important acreage upon the Miami silt loam, although the area annually sown to this crop is decreasing. Yields range from 12 to 30 bushels, with a general average of about 18 bushels per acre. It is the usual practice to plow the oat-stubble land for wheat and to seed timothy with the wheat in the fall. In the spring an additional seeding of clover is made upon the wheat.

The growing of hay crops is important on the Miami silt loam. The acreage devoted to mixed timothy and clover probably exceeds that of any other single crop on the type. The yields secured are excellent, ranging from 1½ tons to as high as 2½ tons per acre. A smaller acreage of clover alone is grown, giving about the same yields. Usually the mixed seeding is cut for two or more years, and a crop of timothy seed is sometimes secured from the last cutting or the meadows are grazed before being broken for corn. The second crop of clover is often matured for seed. Timothy yields 7 or 8 bushels and clover 1 to 2 bushels of seed per acre.

In some parts of southeastern Wisconsin alfalfa has been successfully grown on the better drained areas of this soil. The yields range from 2½ to 5 tons per acre in three cuttings. The acreage of alfalfa upon this and associated soils of the Miami series is steadily increasing in this region. It has been found that inoculation of the soil is essential to success with alfalfa, and it is considered advisable to use ground limestone rock at the rate of a ton or more per acre where alfalfa is to be seeded. Even where there is a considerable amount of limestone gravel in the deeper subsoil the use of lime to sweeten the surface soil is generally necessary.

Some of the more rolling and rougher areas of the Miami silt loam, where the surface is too uneven for cultivation, afford excellent natural pasturage in which Kentucky bluegrass usually predominates. These pastures are maintained permanently in sod.

Potatoes are nowhere grown to any extent as a commercial crop on the Miami silt loam. Nearly every farm annually produces a small acreage for home use. The yields range from 75 to 150 bushels per acre, and it is probable that improved methods of fertilization and cultivation would make the crop a commercial possibility.

Beans are grown to a limited extent in some localities in southeastern Wisconsin, giving an average yield of about 20 bushels per acre. Sugar beets also are grown in this section and the yields range from 10 to 15 tons per acre. The production of tobacco is chiefly confined to the deep phase of the type. A field is shown in Plate XI, figure 2.

Many of the farms on the Miami silt loam include small orchards for the home supply of fruit. Where orchard locations are well selected upon rolling or hilly ground, giving good air and water drainage, the winter varieties of apples are successfully grown. Cherries and plums do well in the home orchards. It is hardly advisable to attempt commercial orcharding on any large scale on this soil.

The usual crop rotation on the Miami silt loam in Indiana consists of corn grown for one or more years, followed by oats for one year; then winter wheat is grown for one year, and a seeding to mixed timothy and red clover or to clover alone is made on the wheat, and the land is devoted to hay for one year. The field may be pastured for one year or the sod turned under to return to corn. There is a constant tendency to grow as large an acreage of corn as possible and to reduce the acreage in wheat. It is claimed that the yields of winter wheat are not as large as in former years and the production is such that other crops prove more profitable upon this high-priced land. In southeastern Wisconsin, barley has almost completely displaced wheat and wheat growing has been practically discontinued. The usual crop rotation in this section consists of corn for one year, followed by oats one year and then barley, or the barley may be omitted. In either case a seeding to mixed timothy and clover is made with the small-grain crop and the land is usually kept in hay for two or more years. The sod is then plowed for corn.

In the dairy regions stable manure is the chief fertilizer used on the Miami silt loam. It is usually applied to the corn ground either on the sod before turning under or on the plowed land to be harrowed in before the planting of the crop. In some cases a commercial fertilizer is used with the small grain crop. In Indiana the use of commercial fertilizer is more general. It is applied at the rate of 150 to 250 pounds per acre on the corn, and a like amount is frequently applied with the wheat. One of the chief needs of this soil is the restoration of organic matter, and the more general use of stable manure is to be recommended. Where possible it is

also advisable to use some of the leguminous crops, such as clover, for green manuring. Regularly plowing under a good clover sod in the rotation is a fairly satisfactory means of maintaining the organic-matter supply in the surface soil.

The Miami silt loam is used for somewhat different types of farming in the various areas where it has been mapped. Its chief use in southeastern Wisconsin is for mixed general farming, with the dairy industry as an important part of the system. Many excellent herds of registered and grade cows of the leading dairy breeds are maintained. The crops most successfully grown—corn, clover, alfalfa, and oats and barley—are all suitable for dairy feeding. The dairy farms are usually well improved with modern farmhouses, large dairy barns, silos, and necessary outbuildings. The fertility of these farms is well maintained by the use of stable manure, and the crop yields are quite generally satisfactory. In Indiana a much larger proportion of the type is used for grain farming, supplemented in many instances by the fattening of beef cattle and the growing of hogs. Where beef cattle are fattened the improvements are about the same as upon dairy farms. Both systems of agriculture are well suited to this soil. Where the production and sale of grain is made the chief object, the buildings are not usually so complete and the crop-producing power of the land is not so high. This probably arises to a considerable degree from the lack of stable manure, the use of which is of great benefit to this soil.

The majority of the farms on the Miami silt loam are in good condition and show evidences of a prosperous state of agriculture.

Flat phase.—The flat phase of the Miami silt loam is almost exclusively confined to the areas surveyed in central and west-central Indiana. These areas include Boone, Hamilton, and Tipton Counties, where this phase predominates, and portions of Montgomery and Tippecanoe Counties, where it is subordinate in area to the normal or rolling phase of the type.

In this region the Miami silt loam, flat phase, is a light-colored upland soil, locally known as "clay land" to distinguish it from the black silty clay loam soils with which it is commonly associated. It occupies from 40 to 60 per cent of the total area in this section.

The surface soil to an average depth of 10 inches is a light-gray silt which varies in color from ashy gray when dry to a pronounced brownish-gray under normal moisture conditions. It is a soft, flourlike material which contains few coarse particles and which is usually rather deficient in organic matter.

The subsoil to a depth of 25 to 30 inches is a stiff silty clay loam or clay. The upper part of the subsoil is frequently mottled yellow and gray, and may be somewhat friable. With increasing depth it

becomes more compact and claylike. The lower part of the 3-foot section is usually a brownish clay or clay loam containing considerable sand and gravel. At greater depths the material becomes distinctly gravelly and sandy, and numerous bowlders are encountered. The flat phase grades into the Clyde silty clay loam in depressions where there has been a considerable accumulation of organic matter, and into the normal or rolling phase of the Miami silt loam where the topography becomes somewhat more rolling and the covering of silt over the underlying sandy and stony clay is of less depth. This phase of the type is practically stone free at the surface.

The surface of practically all of this phase is only very gently undulating, while considerable tracts are nearly level. Some small areas of low relief are found within the phase. The depressed and nearly level areas are usually rather poorly drained, and only the more elevated areas lying along the crests of low swells have fair to good natural drainage. The greater part of the phase would be materially benefited by the installation of tile underdrainage.

The flat phase of the Miami silt loam originally supported a mixed growth of hardwood timber in which beech predominated. It came to be known as "beech land," in distinction from the more rolling phase of this type, which was known as "sugar-tree land" because of the greater abundance of sugar maple. With the exception of small woodlots, the phase has been cleared, and probably 90 per cent of its area is under cultivation.

Corn is extensively grown, giving yields which average somewhat below 40 bushels per acre. During exceptionally wet years the yield is far below this, and extreme drought also exerts a very unfavorable influence upon the yield. This phase is not so well suited to corn production as the more rolling part of the type, and the yields are frequently below the average for the region.

Wheat is commonly grown and constitutes the chief small-grain crop on this phase of the type. The yields range from 12 to 20 bushels per acre, with an average of about 15 bushels. Oats are also grown, and in years of abundant rainfall give excellent results. The yields range from 30 to 50 bushels per acre, with an average of approximately 35 bushels.

Timothy and clover constitute the chief hay crops. Timothy is well suited to this soil, while red clover is not so successfully grown as on the more rolling phase.

Tomatoes for canning are grown to some extent, and potatoes and garden vegetables are produced for home consumption.

Deep phase.—The deep phase of the Miami silt loam has been mapped extensively in south-central Wisconsin, where it occurs in Dane, Columbia, and Fond du Lac Counties.

The surface soil of this phase extends to an average depth of 10 inches and consists of a light-brown friable silt loam. The color of the surface soil when dry is ashy gray. The subsoil is a yellow silt loam, which becomes heavier with increased depth, grading into a yellowish-brown silty clay loam at 20 to 24 inches. This material usually extends to a depth of 3 to 6 feet, where it is underlain by glacial till consisting of a mixture of sand, silt, clay, and gravel. There is a sharp line of demarcation between the silty material forming the surface soil and the immediate subsoil and between the subsoil and the deeper glacial till. Stone and gravel are almost entirely lacking in the surface 2 or 3 feet, but are numerous in the deeper subsoil. A large part of this stony material consists of limestone. In some localities the underlying rock is encountered at a depth of 2 feet or less. In general stony areas are of small extent within this phase.

The topography of the Miami silt loam, deep phase, is gently rolling or undulating, and the surface slopes are generally smooth and gentle. Differences of elevation of 100 feet or more occur within the phase, and there are some distinctly hilly areas of rather small extent. The phase occupies the tops and sides of the low, rolling hills and the more gently undulating intervening plains. In a small area west of the Wisconsin River, in Columbia County, this phase is distinctly hilly, with differences in elevation of 500 or 600 feet. In general the surface drainage of the phase is good, although small depressed areas are in need of tile underdrainage.

The deep phase of the Miami silt loam is the most productive part of the type. Practically all of it is under cultivation, all the general farm crops of the region being produced. Corn is the leading crop, and average yields of 40 bushels per acre are secured. Yields of as much as 70 bushels have been obtained. Oats occupy the largest acreage of any small-grain crop and give yields of 35 to 70 bushels, with an average of 40 bushels per acre. Barley also is grown, producing 20 to 45 bushels per acre. Some winter wheat is grown, giving acreage yields of 15 to 30 bushels. The acreage of both wheat and barley is said to be decreasing. The thrashing of small grains on a farm located on this phase in southern Wisconsin is shown in Plate XII, figure 1.

A large area of this phase is seeded to mixed timothy and clover, and yields of 1 to 2½ tons of hay per acre are secured. In some localities difficulty has been experienced in securing a stand of clover, and timothy is being seeded alone.

In Columbia County, Wis., several special crops are grown to advantage on this phase. Green peas for canning produce 1,800 to 2,000 pounds per acre. Where allowed to mature, a yield of about 15 bushels per acre of seed peas is secured. Beans also are grown,

giving an average yield of about 20 bushels per acre. Some sugar beets are planted, producing from 10 to 15 tons per acre of beets of good quality. In southern Wisconsin the binder type of tobacco is grown on this phase, giving yields of 1,000 to 1,500 pounds per acre. Potatoes are grown chiefly for home use.

It is a common practice on the deep phase of the Miami silt loam to use a rotation consisting of corn, followed by a small grain, either oats, barley, or wheat, then seeding to timothy and clover. The small grain is sown either one or two years. Hay is usually cut for one or two years, and the land is sometimes pastured for an additional year. The field is then manured and again plowed for corn.

General farming, consisting mainly of the production of hay and grain, and dairying are the dominant types of agriculture practiced on this phase. Where local market facilities are good the growing of special crops, such as sugar beets, peas, beans, and tobacco, is practiced in conjunction with the production of the more common farm crops.

The farms on the deep phase of the Miami silt loam are commonly well equipped with buildings, work stock, and machinery, and indicate a generally prosperous condition. While farming conditions are fairly good, the average yields produced upon this phase are somewhat below the natural capacity of such a soil. The rather general lack of organic matter in the surface soil should be corrected by the use of stable manure and the plowing under of green manuring crops. The use of ground limestone at the rate of 1 ton or more per acre would assist in securing a better stand of clover, and alfalfa can be grown successfully only where such an application is made.

The Miami silt loam, in its different phases, is a fairly good general farming soil, suited to the growing of small grains and grass and giving fair to good results with corn. The flat phase is rather poorly drained and yields are generally low in years of excessive rainfall. It is also difficult to secure good yields under drought conditions because of the tendency toward the baking of the surface soil. Underdrainage and the incorporation of large quantities of organic matter will tend to remedy this condition.

The normal phase of the type is usually sufficiently rolling to have fair natural drainage, although some nearly level areas and many small depressed areas are in need of tiling. The rolling areas of this phase are adapted to a wide range of farm crops and are also better suited than any other part of the type to the growing of home orchards of winter apples and other fruits. The deep phase of the type is generally well drained and somewhat superior to other parts of the type, especially for corn production.

Although the deeper subsoil of all parts of the type is usually well supplied with limestone, it has been found that the surface soil is decidedly benefited by the application of ground limestone at the rate of 1 ton or more per acre. The limestone is helpful in securing better stands of clover and decidedly essential to the growing of alfalfa.

Hay, oats, and corn constitute the crops most extensively grown, while winter wheat and barley are also important. In the more southern areas hay and grain production and the fattening of beef cattle are the dominant industries, while in Wisconsin the growing of general farm crops and dairying predominate.

THE MIAMI CLAY LOAM.

The Miami clay loam is most extensively developed in Indiana, Michigan, and Ohio, though small areas are found in Wisconsin and Iowa. A total of 2,342,410 acres of this type has been mapped in the five States in which it has been encountered. The soil surveys already completed, however, indicate that the Miami clay loam constitutes one of the dominant soils of central and western Ohio, northern Indiana, and southern Michigan. From all of the localities in which this type has been recognized its area extends into bordering counties, indicating the existence of millions of acres of the type within the general region in which the Miami series is developed.[1]

The surface soil of the Miami clay loam is a brown, yellow, or gray silty loam. The depth of this surface soil is rarely less than 6 inches, except in small areas on steep slopes, where erosion has been active. It is generally more than 10 inches in depth, constituting an unusually deep surface soil. This material is frequently underlain by a yellow or brown heavy silty loam which extends to a depth of about 2 feet, and this in turn is underlain by a brown, yellow, gray, or drab, frequently mottled silty clay loam or heavy clay. At a depth varying from 2 feet to 5 or 6 feet the typical blue or drab bowlder clay, with the characteristic glacial pebbles and bowlders, is almost universally developed. Only on slopes and in other localities where the surface soil and subsoil are unusually shallow is the consolidated underlying rock encountered. Usually the depth of the glacial till over bedrock is from 40 to 250 feet. The Miami clay loam is derived from deep, complex, mechanically broken soil-making material of glacial origin. The soil itself has been slowly formed through the processes of weathering of the surface portion of this material. The glacial origin of the soil, insuring the commingling of earthy material from a great variety of sources, the great depth of the soil-making material, and the compact nature of the mass which resists exces-

[1] It is probable that some areas of Miami silt loam have been included with areas of the Miami clay loam in some of the earlier soil surveys in Ohio and Indiana.

sive erosion all tend to form a soil of medium to good fertility and of a most durable quality under even fair conditions of agricultural use.

In many regions where the Miami clay loam is encountered, scattered bowlders and small stones are found locally over the surface of the type, and in increasing quantities in the deeper subsoil and underlying till. In some small areas this accumulation of stone may be sufficient to interfere somewhat with cultivation. In such cases the stone is usually gathered from the field and used in the construction of fences or buildings. In general, however, the surface soil is fairly free from any large masses of rock or extensive accumulations of stone and gravel. The larger rock masses associated with the Miami clay loam roughly indicate the character of the finer grained soil-forming material. The bowlders, stone, and gravel comprise fragments of practically every known variety of igneous, metamorphic, and sedimentary rock occurring within the area occupied by the type or within the extensive tracts to the north from which the glacial ice passed southward to deposit its load. Granites, gneisses, schists, sandstone, limestone, and quartzite are all found among the glacial bowlders and pebbles. The softer rocks, such as shale, have usually been so finely ground by glacial action as to prevent identification in the majority of the areas. Usually a large part of the rock fragments in the deeper subsoil consists of limestone.

Considering the wide extent of territory over which the Miami clay loam is developed and its derivation from ice-laid materials, the surface configuration of the type is unusually uniform, or at least varies within reasonably narrow limits. In general, the surface of the type is gently undulating or slightly rolling with local low, rounded hills or steep-sided knobs in areas which include distinct glacial moraines. The only other hilly or steeply sloping areas of the Miami clay loam are those found where postglacial streams have cut deeply below the glacial upland surface, and have extended their minor branches through the upland areas occupied by the Miami clay loam.

The altitudes at which this type is developed vary from approximately 600 feet above tide level in the vicinity of Lakes Erie and Michigan to altitudes of a little more than 1,300 feet in southwestern Ohio and southeastern Indiana. These differences in altitude arise chiefly from differences in the elevation of the rock floor over which the glacial materials were laid down. The rolling surface of the soil type itself slopes gently upward from its lower elevations to the highest altitudes attained near the southern boundary of glaciation.

There is considerable variation in the natural drainage of the Miami clay loam. The more nearly level areas, especially those some-

what remote from lines of pronounced stream drainage, are usually wet and poorly drained. This is due both to the level surface of the soil and to the great depth of the massive, stiff glacial clay from which the soil itself has been formed. Thus, both the surface drainage and the internal soil and subsoil drainage are deficient over such areas. In the more rolling portions, such as comprise extensive areas in southern Michigan, west-central Ohio, and eastern Indiana, the drainage of the type is unusually good, and for this reason it was frequently selected for settlement in pioneer days. In no case is the drainage of the Miami clay loam excessive.

Erosion constitutes a soil problem only in the steeper sloping areas of the Miami clay loam where the land breaks sharply from the general upland level down to the valley of some deeply incised stream course. Such areas are usually maintained in forests or woodlots, or at most are occupied for permanent pasture, so that the erosion problem upon this type is scarcely worthy of serious consideration.

The organic-matter content of the surface soil varies with the slope of the type and with its condition of natural drainage. In lower lying hollows and at the lower altitudes there is a tendency toward the accumulation of organic matter, resulting in the darker brown to black coloring of the surface soil and frequently in a more mealy and friable structure. In such locations the material grades toward the soils of the Clyde series, the silty clay member of which is generally associated with this type. Over the greater part of the area of the Miami clay loam the surface soil is brown or gray in color. In such areas a moderate amount of organic matter is present within the surface soil and the best conditions for crop production are thus indicated. On steep slopes, where erosion has been active, the surface soil is frequently absent and the brown, pale-yellow, ash-colored or blue subsoil material is exposed. Very little organic matter is present in the surface material of such areas, and the incorporation of organic manures is necessary. In general, the organic-matter content of the Miami clay loam, particularly in forested regions, is about the average for upland glacial soils.

All areas of the Miami clay loam mapped lie within the cool temperate region of central United States, which is supplied with abundant but not excessive rainfall. This fact, coupled with the fine texture and dense structure of the soil material itself, restricts the use of the soil to the production of general farm crops, particularly the small grains and grasses. Thus the Miami clay loam is a general farming soil rather than a special-purpose soil, and its crop adaptations are such as to encourage the production of small grains.

The increased yields of the general farm crops secured upon such tracts of this type as have been adequately tile drained indicate that

this is one of the most effective methods of improving the Miami clay loam. Particularly where the surface features are level to gently undulating, where farm lands are remote from deeply cut stream trenches, or where depressions exist over the surface of the type, the installation of tile drains is of fundamental importance in the proper utilization of this soil. The contrasts in crop yields between properly drained and poorly drained areas of the type, whether this drainage is accomplished naturally or through the installation of tile, are marked. With adequate drainage the Miami clay loam ranks high, not only for the production of winter wheat, oats, and grass, but also as a corn-producing soil. On the other hand, where drainage is deficient the production of corn and of winter wheat is practically impossible, or the yields secured are too small to justify the growing of these crops. There are areas of the Miami clay loam, particularly in the more eastern States, which, because of poor drainage, have not been cleared and brought under cultivation until within the last half century, and then only through the construction of open ditches and the installation of systems of tile drainage. Flat areas which have not been so treated still produce small crop yields where they are farmed and do not possess that wide range of cropping possibility which is essential to a well-balanced system of general farming. The cost of tile draining a stiff, impervious soil of this character, and especially one where the deeper subsoil is likely to contain considerable masses of stone or even large bowlders, is rather high, ranging from $20 to $30 an acre for the complete drainage of entire fields. Nevertheless, when this is considered as an investment, adding to the permanent value of the land, it is usually justified, not only by the increased yields secured, but also by the rapidly increasing value of the land itself. Tile drains to be effective upon the Miami clay loam should have considerable internal diameter and adequate fall along the ditch line, and should be placed at rather frequent intervals and at an average depth of not less than 3 feet. These requirements give rise to the rather high cost of adequate underdrainage of the type.

The frequent incorporation of a reasonable amount of organic matter in the surface soil is also requisite to maintain or to increase the efficiency of the Miami clay loam. The prevailing systems of farming upon the type are fairly adequate for this purpose, in that grass constitutes an important crop in the regular rotation practiced over practically the entire area of this soil. The plowing under of the sod in the preparation of the land for corn or other hoed crops assists in the maintenance of organic matter in the soil, while the keeping of beef cattle and of dairy cows upon the areas of this type renders the application of stable manure possible over a large part

of the arable acreage each year. The better farmers throughout the section occupied by the Miami clay loam practice these methods of organic-matter restoration and are well repaid by crop yields being maintained and even increased.

In connection with the production of the grass crops, particularly the clovers, the application of lime to this dense, compact soil results in increased yields wherever it is properly practiced. Either finely ground limestone rock or the burned stone lime may be used for this purpose. Where the powdered limestone is used, considerably larger applications are required than in the case of the quick lime. In the latter case applications of 1,500 to 2,000 pounds per acre result in marked increases in the yields of clover hay. At least double this quantity of ground limestone is necessary in order to secure the same results.

Another method for securing improvement in the crop yields of the Miami clay loam consists of the maintenance of the best tilth possible in the surface soil. The fine texture of the surface soil gives rise to a tendency toward clodding and baking unless the land is handled when the moisture conditions both of the surface soil and subsoil are particularly favorable. Plowing should not be attempted either when the soil is thoroughly baked and hardened or when it is wet and soft. In the former case large clods are formed which are very difficult to break down into a favorable condition by any subsequent tillage operations. In the latter case both the surface soil and the subsoil at plow depth are likely to become puddled and to form a "hardpan" or other physical condition unfavorable to the processes of root growth. A little care in the plowing of this land when it is in the condition of optimum moisture content will usually obviate both of these difficulties. It should be held in mind, moreover, by every owner of land of this character that the soil resources locked up in the baked and hardened clods are absolutely unavailable for the use of the growing crops, besides constituting a danger in the cultivation of the intertilled crops through the breaking down of the young plants. Thorough harrowing, preferably with the disk harrow, will generally serve to break up the surface clods, and the use of some such tillage implement is necessary in the proper preparation of the land.

There are few special crops which are suited to production upon the Miami clay loam, and the best types of agriculture conducted upon this soil are those embodying the production of grain and grass and the utilization of these for feeding dairy cattle and other stock. In the more rolling areas, especially where the low hills of the morainal belt are found, apple orcharding may be undertaken on a small scale. Even in such areas the heavy texture of the soil and

the dense subsoil limit the varieties which may be produced. Pears constitute the only orchard fruit other than apples that is well suited to a soil of such heavy texture.

Tobacco is produced on the Miami clay loam in southern and southwestern Ohio in areas which are particularly well drained, are heavily manured and fertilized, and which have been brought into good mechanical condition by careful tillage. These constitute practically the only special crops which are suited to production upon the Miami clay loam, both because of its textural peculiarities and because of the climate.

The Miami clay loam, locally known as "maple land" or "walnut land," from the dominant species of its native hardwood trees, was selected for clearing and settlement early in the pioneer days in Michigan, Ohio, and Indiana. The type supported a heavy growth of a great variety of hardwoods. Throughout Ohio it was forested with oak, maple, beech, basswood, walnut, poplar, cherry, ash, elm, hickory, black gum, buckeye, and ironwood. In localities where the maple or walnut prevailed the type soon attained a wide reputation for its fertility and sustained crop-producing power. In general the lands occupied mainly by a beech forest were not so highly esteemed, while the growth of black gum and elm usually indicated low-lying areas within the type in which the natural drainage was too poor for their immediate occupation.

The gently undulating or rolling surface of the Miami clay loam was favorable for agriculture, and as the timber was removed a steadily increasing acreage was used for farm crops. At present over 80 per cent of the total area of the type is either arable land or is held in more or less permanent pastures, which are occasionally plowed for the production of a crop. The remainder of the type consists of woodlots, the somewhat hilly and stony areas which are occasionally encountered, and those steeper slopes along the margins of the type where the upland surface breaks down to the deeply trenched streams.

In general the Miami clay loam is highly prized as an agricultural soil. Its value varies, depending upon its location with respect to markets and to transportation facilities, from $50 or $60 an acre to $250 or more where the land is located near the outskirts of the larger manufacturing cities.

There is little possibility that the area of the Miami clay loam under cultivation may be greatly extended. Such extension may occur only through the draining of areas which still remain somewhat swampy or through the clearing of forested areas which are required for the use of the farms upon which they occur. The former improvement might well be undertaken. The clearing of woodlots could scarcely be called an improvement.

The Miami clay loam is principally devoted to the production of corn, wheat, oats, and hay. Of the grain crops the acreage of corn takes first rank, the crop being extensively grown upon this type in Indiana, Michigan, Ohio, and Wisconsin. In general, the dent varieties of corn, either white or yellow, are produced in the more southern regions, while to a small extent in Michigan the flint corn is also grown upon this type. In Indiana the yields of corn range from 25 to 60 bushels per acre, with an average yield of something over 40 bushels per acre. In Michigan the yields range from 25 to 50 bushels, with an average of about 30 bushels per acre. In Ohio corn upon the Miami clay loam produces from 30 to 60 bushels per acre, with an average yield of about 40 bushels. In Wisconsin, the yield is 25 to 40 bushels per acre, the average being about 35 bushels. In the areas where the Miami clay loam has been mapped in Indiana the acreage annually devoted to corn exceeds that devoted to any other grain crop, wheat being second in acreage and oats third. In Ohio the acreage devoted to corn is usually greatest, although in some instances this is exceeded by either wheat or oats, while in Michigan wheat is the crop most extensively grown, with corn second in acreage and oats third. In general the Miami clay loam is not considered quite as good a corn soil as the Clyde silty clay loam, or the Marshall silt loam, when these occur in the same areas where the Miami clay loam is found. It is, however, an excellent corn soil measured by the average yields produced, even in the great corn-growing region of the central prairie States, and with proper drainage and careful preparation of the land annual yields averaging from 45 to 50 bushels may be expected. The corn is usually planted on sod which has been turned under, and not infrequently applications of stable manure are made. In general, the Miami clay loam occupies a region in west-central Ohio and east-central Indiana where the average production of corn is in excess of 40 bushels per acre. The only regions of any extent in which this yield is exceeded are those somewhat farther to the west, which are occupied mainly by the Marshall silt loam. Thus the Miami clay loam may be ranked as one of the important corn soils of the United States.

The majority of the farmers consider the Miami clay loam even better suited to the production of wheat than to the growing of corn. Of the total area of the Miami clay loam which has thus far been mapped, the counties in which the type constitutes more than one-half of the total area show an acreage devoted to wheat only less than that devoted to corn, and the computed average yield of wheat per acre in such counties in Indiana and Ohio is slightly more than 17 bushels. Wheat yields, ranging from 15 to 25 or 30 bushels per acre, have been reported in these States, and it is probable that the average for the Miami clay loam considerably exceeds the general

average for the counties in which it occurs, since in each case it constitutes the best wheat soil of the area. A typical field of wheat on the Miami clay loam is shown in Plate XII, figure 2. Usually wheat is seeded on land upon which corn has been produced the preceding year. The winter varieties only are grown, spring wheat being practically unknown in this section. In Michigan the area devoted to wheat usually exceeds that devoted to any other grain crop on this soil type, and the average yields upon all soils in the counties of which soil surveys have been made are in the vicinity of 13 bushels per acre. The yields reported from this soil type in the same counties are 15 to 25 bushels per acre, indicating again that the Miami clay loam is a good wheat soil. Complete commercial fertilizers are sometimes used with the wheat seeding, but in general the fertilizers incorporated with the soil in the preparation of the land for corn are chiefly relied upon for the production of the succeeding wheat crop. In many cases wheat is produced two years in succession, and grass is seeded with the second crop. In other instances oats are seeded upon the corn land and followed by wheat.

The acreage devoted to oats in the counties in which soil surveys have been made and in which the Miami clay loam predominates is usually subordinate both to the wheat acreage and to the acreage in corn, although in some instances the acreage in oats is second only to that devoted to corn. For these counties Census statistics indicate an average yield of over 35 bushels of oats per acre. In Indiana the average yields for the Miami clay loam are stated in the soil survey reports at 30 to 35 bushels per acre, while in Michigan and Ohio the average yields are given as 40 to 60 bushels per acre. These estimates are fully verified by an examination of the statistics of yields in the counties mapped. As has been noted, oats frequently take the place of wheat as a first-year small-grain crop. In other instances, particularly in Michigan and the northern part of Ohio, the wheat is entirely displaced by oats, which are seeded only for a single year, being immediately followed by grass.

The area devoted to grass growing and hay production in the counties in which the Miami clay loam is the dominant soil type almost equals the area devoted to the production of the grain crops. This is due to the fact that grass usually occupies the ground for two or three years in the regular rotation, being cut for hay during the first and second years and not infrequently pastured the third year preparatory to breaking the ground for corn. The average yields for the counties in which soil surveys have been made exceeds 1.3 tons of hay per acre, and again the Miami clay loam may be credited with a yield greater than the average for these counties. On this type the yields range from 1 to 2 tons per acre, and the latter yield is sometimes exceeded. In all areas where the Miami

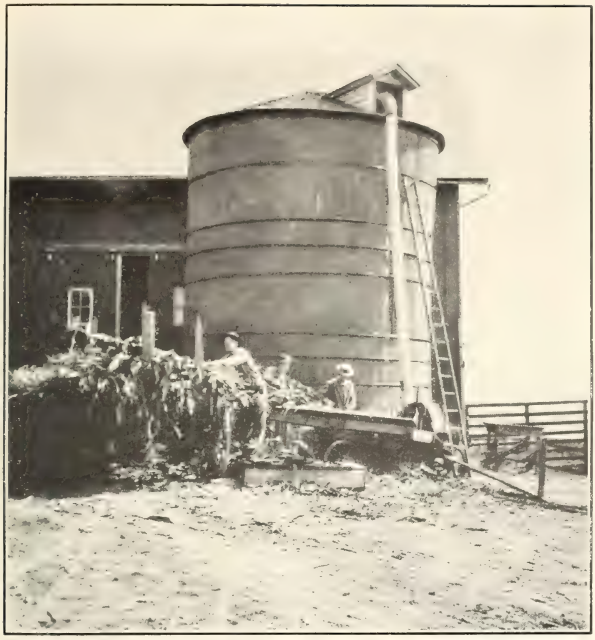


FIG. 1.—CUTTING CORN INTO THE SILO ON A DAIRY FARM LOCATED ON MIAMI SILT LOAM IN SOUTHEASTERN WISCONSIN.

FIG. 2.—TOBACCO ON MIAMI SILT LOAM, DEEP PHASE, IN SOUTHEASTERN WISCONSIN.

FIG. 1.—THRASHING SMALL GRAINS ON THE MIAMI SILT LOAM, DEEP PHASE, IN SOUTHEASTERN WISCONSIN.

FIG. 2.—A TYPICAL FIELD OF WINTER WHEAT ON THE MIAMI CLAY LOAM IN WEST-CENTRAL OHIO.

[Note the nearly level surface of this soil type.]

clay loam occurs the rougher and more sloping portions of the type, together with many areas which may be so covered with bowlders as to make cultivation difficult, are usually devoted to permanent pastures. The growth of native and tame grasses is excellent, and many pastures have been maintained from 50 to 100 years without reseeding or breaking the sod.

Of the principal crops suited to the middle temperate region, the Miami clay loam ranks high in the production of corn, wheat, oats, hay, and pasturage grasses. It is therefore one of the most important general farming soil types in the eastern part of the Central States.

In addition to the crops above mentioned, which dominate the agricultural practice of the region and the type, rye is also occasionally produced in Michigan, giving yields of 15 to 25 bushels per acre. Barley production is confined to southeastern Wisconsin, and the yields reported vary from 20 to 40 bushels per acre. Beans also constitute an important crop in southern Michigan, producing from 10 to 22 bushels per acre, and the latter yield is sometimes exceeded. In central Indiana tomatoes are being produced as a canning crop, yielding 200 bushels per acre, and in the same region green peas are raised for the city markets and as a canning crop, giving yields of about 2,000 to 2,500 pounds per acre. These constitute secondary special crops, chiefly of local importance and produced because of local market conditions.

In central and southern Michigan the Miami clay loam is also frequently used for the production of sugar beets. This crop takes the place of a part of the corn acreage in the regular rotation and has been produced extensively in this general region. The yields vary from 6 to 12 tons per acre, and the beets usually have a high sugar content and a high index of purity. The crop is grown only in the vicinity of established sugar-beet factories or in neighboring localities where transportation to the factories is well provided.

Another special crop producted on the Miami clay loam is the Spanish Zimmer tobacco, grown in the Miami region of southwestern Ohio. In this region the tobacco usually follows the corn crop, and the Miami clay loam is considered the best soil in the area for the production of tobacco. Nearly every farm includes a small field, ranging in size from 3 to 8 acres, while some growers produce from 10 to 30 acres each year. The tobacco grown upon this soil has good body, good sweating properties, and is fine fibered and elastic. The best filler leaf produced in the region is grown on the rolling upland areas of the Miami clay loam.

Among the tree fruits only apples and pears do well on the Miami clay loam, and even with apples it is necessary to discriminate in the selection of particular areas of the soil for the planting of orchards and also in the selection of varieties suited to such a heavy

type of soil. It is only on the more rolling and better-drained uplands, where both surface and internal drainage are well established and where the air drainage over the orchard sites is good that apple orcharding upon a commercial scale should be undertaken. Lower lying areas where water drainage is interrupted or where the air does not circulate freely should be avoided for any extensive apple planting. The varieties best suited to this type are the old standard northern winter apples, the Rhode Island Greening and the Northern Spy. Of these varieties the soil is probably best adapted to the Greening. Although other varieties may be grown, these are preferable for commercial plantings.

The soil is altogether too heavy and the subsoil too dense for the production of peaches. Upon well-drained areas of the Miami clay loam the small fruits, particularly raspberries, currants, and strawberries, do well and may be grown successfully not only for home supply but also for near-by city markets.

There has been very little development of market gardening or trucking on this type, with the single exception of a locality in central Indiana, where tomatoes and green peas are the principal crops grown. There is an excellent opportunity for the production of cabbage and even of onions upon the lower lying portions of the type, especially where the dark-colored muck soil, which is frequently found in the hollows within the area of the type, has a depth of 6 to 8 inches or more.

In general, however, the Miami clay loam is too valuable as a grass and grain producing soil to be devoted to special crops, except in cases where local market demands are unusually strong, or where there are exceptional opportunities for rapid transportation to the larger cities.

As a result of the crop adaptations of the Miami clay loam, the proper disposal of the farm crops annually produced has led the majority of farmers into some form of animal production to supplement the sale of corn, or wheat, or other grain crops. In some parts of Ohio and in southern Michigan dairying constitutes the chief means of such crop disposal. Both corn and hay are extensively fed to dairy cows, while the areas of pasture are utilized for the summer production of milk. A part of the milk is shipped to the large cities, but the greater part of it is sold to local creameries and cheese factories. In this connection young stock, including calves and swine in large numbers, are fed for the purpose of a supplementary sale of beef, veal, and pork. In central Indiana and west-central Ohio the fattening of beef cattle is an important industry on this type. It is within the area ocupied by the Miami clay loam also that the principal sheep-breeding industry still maintained in the Eastern States is located. The sheep are now kept

largely for the production of early spring lambs, although the wool clip constitutes an important source of revenue in many areas where this type has been encountered. Not as many sheep are kept within this general region as in the early days of wool production, but the number now maintained is steadily increasing with the increased price of spring lamb.

It is wholly impossible properly to till the Miami clay loam with light-weight farm teams or light tools. This is thoroughly recognized throughout practically all areas where the type occurs, and as a result the heavy two-horse teams and the more powerful forms of farm machinery are in common use. With these teams and implements deep plowing of the surface soil is possible, and thorough harrowing and tillage of the type can be conducted at later stages. The use of heavy teams and improved machinery is shown in Plate XIII, figure 1. A large part of the crops grown is planted or sown by the use of the two-horse corn planter or the large-size grain drill with fertilizer and seeder attachments. Disk harrows and riding cultivators are also used extensively. The farm equipment is usually adequate and substantial.

Because of the general practice of some form of stock raising within the territory occupied by the Miami clay loam, the farm buildings are large and substantial and the region is marked by well-painted houses, large and well-constructed hay and dairy barns, and in some sections by the necessary equipment of well-built tobacco barns. Not infrequently the farms on this type also possess the requisite equipment for the manufacture of maple sugar or sirup from the groves of sugar maples remaining in many areas. In general the teams, implements, and buildings upon the Miami clay loam give the appearance of a well stocked, adequately equipped, and well cared for farming territory. Typical farm buildings on the Miami clay loam in western Ohio are shown in Plate XIII, figure 2.

CROP USES AND ADAPTATIONS.

The soils of the Miami series are principally developed in the humid portion of the northern temperate region. Within the territory occupied by these soils the average annual precipitation ranges from slightly in excess of 40 inches in southern Ohio and Indiana to a little more than 30 inches in northern Michigan and Wisconsin. Over the greater part of the region it amounts to more than 32 inches, and in some localities exceeds 40 inches. Throughout the greater part of this area the precipitation is well distributed for crop production, since a large part of it occurs during the growing season.

The length of the growing season, or the normal interval between killing frosts in spring and fall, varies widely in the different sections of this territory. Thus in the southern areas, in southern and central Ohio and Indiana, the length of the growing season is approximately 175 days. The season becomes gradually shorter toward the north, comprising only about 150 days in central Michigan and Wisconsin. Only the most northern developments of the soils of this series have a growing season as short as 125 days under normal conditions.

Since the differences in altitude within this section are in general slight, there are no marked departures from the normal changes in climatic condition caused by differences in elevation. The protective influence of large bodies of water is felt in the case of those areas of the series which lie along the eastern shore of Lake Michigan to a distance of 30 miles or more inland, and, to a less extent, in areas along the western shore of the lake and around Green Bay.

These climatic conditions render possible the production of practically all of the staple crops suited to a temperate climate.

In considering the crop uses and adaptations of the different soils of the Miami series it must be held in mind that the different types are very unequally distributed through the region in which the series is developed. Fully 80 per cent of the total area of the Miami clay loam thus far encountered in the soil surveys lies in Ohio and Indiana. Approximately 50 per cent of the Miami silt loam has been encountered in these two States, while additional large areas occur in the southeastern part of Wisconsin where the climatic conditions are not materially different. All of the Miami fine sandy loam thus far mapped occurs in Michigan and Wisconsin, while the other more sandy and gravelly types, which are subordinate in total area, are chiefly confined to Wisconsin.

This uneven distribution of the types of the series will probably be accentuated as the soil survey work progresses, since it is known that large additional areas of the Miami clay loam and silt loam exist in western Ohio and central Indiana. There is thus a preponderance of the heavier soil types in the more southern latitudes and of the more sandy or loamy types farther north.

Moreover, the gravelly soils of the series and large areas of the more sandy soils are marked by a rather rough topography, and are less well suited to agriculture than the smoother, heavier members of the series.

All of these circumstances tend toward the partial development only of the sandy and gravelly soils and toward a restricted crop use, while the fine sandy loam and heavier members of the series are extensively occupied for the production of a wide range of staple crops.

The Miami sand is of very limited extent, and is too droughty to give even fair yields of staple crops. Low yields of corn, oats, rye, and clover are secured. If this soil were favorably located with respect to markets it would constitute an early truck and fruit soil of considerable value.

The Miami gravelly sandy loam and gravelly loam are somewhat better suited to crop production, giving fair yields of corn, oats, rye, barley, and hay under favorable conditions of rainfall. They are both subject to drought and are chiefly farmed in connection with other soil types. A large total area of each type is used for permanent pasture.

The Miami fine sand produces low yields of the general farm crops. Corn yields about 25 bushels, oats 22 bushels, rye 12 bushels, and timothy and clover hay about 1 ton per acre. It is a fairly good potato soil and beans are successfully grown. About three-fourths of the total area of the type thus far encountered in the soil surveys is under cultivation, while the greater part of the remainder is used for pasture.

The Miami sandy loam has been encountered only to a very limited extent. Its crop uses are about the same as those of the Miami fine sand, but the yields of the staple crops are slightly greater.

The Miami fine sandy loam is the coarsest textured soil of the series that is well suited to the extensive production of the staple farm crops. Practically all of the area of this type so far mapped occurs in the cooler portion of the general region occupied by the soils of the series. The type is everywhere well drained, and the compact subsoil serves to retain moisture to a sufficient degree for maturing crops under conditions of normal rainfall. As a result practically all the type has been cleared and is used for general and special forms of agriculture. A study of the crop uses of this type shows that corn, oats, and hay occupy the largest acreages upon it, producing fair to good yields. Barley, wheat, and rye are grown to a small extent. The yields of wheat are low, and the acreage devoted to this crop is decreasing. Beans are grown to a considerable extent in Michigan, producing fair average yields. Potatoes are well suited to this soil, and are grown to some extent as a cash crop in both Michigan and Wisconsin. The type occurs extensively within the Michigan fruit belt, which extends inland for a distance of 30 miles or more from the eastern shore of Lake Michigan. In this region it is used for apple and peach orcharding and for the growing of cherries, grapes, and small fruits. It is found to be well suited to these crops. Dairying constitutes the principal form of animal industry on the Miami fine sandy loam, although some beef cattle are fattened and hogs also are grown in connection with dairying. Sheep are raised in some localities.

The Miami loam is chiefly developed in southern Michigan, with large areas in about the same latitude in Wisconsin. The occurrence of this type in the more northern sections affects its crop uses, and it is probable that the largest acreage is annually devoted to hay production. Corn is second in acreage and oats are third. The area devoted to the production of winter wheat is next to that used for oats. The yields of all of these crops are good. Corn probably averages something more than 40 bushels per acre. Hay produces about 1½ tons. Oats yield an average of about 40 bushels per acre. The average wheat yield is about 15 bushels. Rye and barley also are grown, giving good average yields. Beans constitute the most important special crop, being extensively grown upon the Miami loam in southern Michigan. The average yield per acre is about 15 bushels. Potatoes are grown chiefly for home use, but a surplus is annually marketed, and the type might well become an important potato-producing soil. Orchard fruits are grown in favored localities, chiefly for home use. Both in Michigan and Wisconsin the dairy industry is well developed on the Miami loam. The crops grown are well suited to dairy feeding, nearly all of the farms include some land best suited to permanent pasturage, and the climatic conditions are suitable for the manufacture of butter and cheese. In connection with the dairy industry, some hogs are fattened. In the bean-growing region sheep also are raised. But few beef cattle are kept on this type.

The Miami silt loam has been mapped chiefly in Indiana and Ohio. Large areas are also found in the southern part of Wisconsin under similar climatic conditions. The larger areas of the type lie well within the "corn belt" and this crop occupies the largest acreage on the Miami silt loam. All of the better drained portions of the type are well suited to corn production, and the average yield obtained is in the neighborhood of 40 bushels per acre. It is an important corn-producing soil although the average yields secured from it are frequently exceeded by those produced on the darker colored soils associated with it. There is a general tendency over the entire type to produce as large an acreage of corn as is possible each year. The acreages given to oats and to hay are almost equal over a considerable part of the Miami silt loam. In the more southern regions of its occurrence the climatic conditions are not especially favorable for oat production, but near its northern limits, as in Wisconsin, this crop thrives and the largest acreage sown to grain is annually devoted to oats. The average yield produced under all conditions of climate and soil is about 40 bushels per acre. The yields in southern latitudes are generally less than those secured farther north. The hay grown on the Miami silt loam is chiefly mixed timothy and red clover, although some localities produce clover alone. The average yields

range from about 1¼ tons per acre in more southern localities to 1¾ tons in southern Wisconsin. The deep phase of the type is one of the best hay soils in the Central States. Winter wheat is extensively grown on the Miami silt loam in Ohio and Indiana, and constitutes the chief small-grain crop in the more southern locations. The yields range from 12 to 30 bushels per acre and statistics of production indicate that wheat on this soil will average from 16 to 17 bushels per acre over large areas through considerable periods of time. It is evident that the acreage of wheat grown upon this type is being reduced somewhat, and it is claimed that the yields have decreased. It is probable that the greater profits secured from the production of corn have contributed to the restriction of wheat production. Barley is grown to some extent on this soil in southern Wisconsin, giving an average yield of 20 bushels or more per acre. Several special crops have been grown with success in different areas of the Miami silt loam. In central Indiana tomatoes are produced for canning, giving a fair tonnage of late tomatoes. Beans are grown to a limited extent in southern Wisconsin. In this region some tobacco also is grown. Nearly all farms upon the type produce sufficient potatoes for home use, but the growing of this crop on a commercial scale is not practiced. Sugar beets are grown in southern Wisconsin, giving large yields of beets of fair quality. The better drained areas of the Miami silt loam in southern Wisconsin have been found to be well suited to growing alfalfa. This crop produces from 2½ to 5 tons per acre.

In all of the more southern localities of its occurrence the Miami silt loam is chiefly used for the production of grain and hay. In part these crops are fed to beef cattle and to hogs, while a part of the grain is sold. In the more northern regions a profitable dairy business is developed on the basis of the large acreage of hay and pasture maintained on the type, supplemented by the use of corn as silage. The crops sold are chiefly the small grains. In general, the type of farming and the character of the crops grown vary to a considerable degree with climatic conditions.

Approximately 75 per cent of the total area of the Miami clay loam which has thus far been mapped occurs in western Ohio and central Indiana. It is certain that from 50 to 80 per cent of the total area of many of the counties in this section is occupied by this soil and the closely related Miami silt loam. The dominance of the type is so marked that the general agricultural practices of the section may be correlated with this soil with a reasonable degree of accuracy. A study of the statistics of crop production in this region shows that the area annually devoted to corn growing is double that given to any other single crop. It is only slightly less than the combined acreage of hay, oats, and wheat, the three next most important crops. This section has a growing season of 160

to 180 days, and is also provided with an abundant rainfall, except at rare intervals. Corn is generally recognized as the most profitable staple crop, and the constant tendency is to increase the acreage planted.

The availability of the Miami clay loam as a corn soil under these climatic conditions is well shown by the average yields secured over large areas and through periods of many years. The various soil survey reports indicate that the range in yield is from 25 to 60 bushels per acre, with a general average of 40 bushels or more. Statistical data confirm these figures, showing an average yield of corn of approximately 44 bushels per acre for the western Ohio counties where this soil is dominant and of 45.4 bushels per acre for similar counties in central Indiana. In each case these yields are above the average for the States. While the figures may be a little high, due to the inclusion of average yields from excellent corn soils found along numerous river terraces and from appreciable areas of black upland soils, they are fairly representative of the capabilities of the Miami clay loam for corn growing. These average yields are only less than those secured from the dark prairie soils of the corn belt, occurring immediately to the west of the region where the Miami soils dominate. All evidences of high present yield, increasing acreage, and numerous instances of yields considerably in excess of the average production indicate that the Miami clay loam is one of the most important corn soils of the eastern part of the central corn-growing belt. The soil survey reports consistently indicate that portions of the type which either possess good natural drainage or which have been tile drained produce corn crops above the average. They also show that yields are increased by the practice of a regular rotation which includes the production of clover or mixed clover and timothy, and that the use of organic manures is essential to the production of high yields of corn.

The acreage in hay crops is second to that devoted to corn in those Ohio and Indiana counties in which the Miami clay loam predominates. The average yields of mixed timothy and clover hay are 1.4 tons per acre in the Ohio counties and a little over 1.3 tons per acre in the Indiana counties. In both cases these yields are above the averages for the respective States. The greater part of the hay produced consists of mixed timothy and clover, although a large amount of clover alone is grown in both these States.

Oats are third in total acreage in these counties, covering but slightly less area than hay. The yields per acre are slightly under 30 bushels in each State, being less than the State averages. The yields of this crop on the Miami clay loam as it occurs in Michigan and Wisconsin are higher than in the more southern localities.

FIG. 1.—FOUR-HORSE TEAM AND RIDING PLOW USED IN THE TILLAGE OF THE MIAMI SILT LOAM AND CLAY LOAM.

FIG. 2.—TYPICAL FARM BUILDINGS ON THE MIAMI CLAY LOAM IN WESTERN OHIO.

The Miami clay loam has its greatest development in the eastern region where winter wheat still constitutes an important crop. The acreage reported in wheat for the Ohio counties dominated by this type is decidedly less than that devoted to oats, but in Indiana the acreage nearly equals that in oats. In both cases winter wheat ranks fourth in acreage among the staple crops. In both States it is generally reported that the acreage in winter wheat is being reduced, although this crop retains an important place in the farming system. The average yield for the Miami clay loam in western Ohio is approximately 14 bushels per acre, the yields ranging from 12 to 20 bushels. In Indiana the average yield is 15 to 16 bushels per acre, with about the same range. In both cases the yields are slightly less than the averages for the respective States. Considerable wheat is also grown upon the Miami clay loam in southern Michigan, and the yields reported are larger than in either Ohio or Indiana. They average slightly less than 20 bushels per acre. The type is undoubtedly well suited to wheat, but the higher returns per acre secured from corn production have tended to increase the acreage of that crop somewhat at the expense of wheat. In the dairying regions, also, the desire to produce the largest possible acreage of forage crops on each farm has led to a gradual abandonment of wheat.

Barley, rye, and buckwheat are grown only to a small extent on the Miami clay loam, although they give good average yields in the more northern localities.

Tobacco constitutes a special crop on the Miami clay loam in southwestern Ohio and adjoining counties in Indiana. On many farms from 5 to 20 acres are annually devoted to tobacco and the yields are good, averaging 1,200 pounds or more per acre. Tomatoes also are grown to a limited extent in central Indiana, chiefly for canning purposes. The type is well suited to this crop.

The Miami clay loam is developed to some extent in the southern counties of Michigan, and small areas are found in southeastern Wisconsin. In Michigan it is probable that the hay crop occupies the largest acreage of any single crop on the type. Mixed timothy and clover constitute the principal hay crop, giving an average yield of about 1¼ tons per acre. Corn is second in acreage, and produces an average yield of about 35 bushels per acre in this more northern latitude. Oats constitute the principal small-grain crop, and the average yield for the Miami clay loam in both Michigan and Wisconsin is undoubtedly in excess of 35 bushels per acre. Some beans and sugar beets are produced on the type.

The dominant form of agriculture upon the Miami clay loam is grain and grass farming. This is supplemented to a small extent

and in restricted localities by the production of special crops such as tobacco and tomatoes. A considerable part of the corn grown is sold, while all of the wheat is produced for cash sale. The balance of the corn, the greater part of the oat crop, and nearly all the forage are fed upon the farm. In Ohio and Indiana the feeding operations consist chiefly of the fattening of cattle bought for this purpose. Associated with the feeding of stock is the fattening of hogs raised on the farm. Many of the counties in western Ohio and central Indiana which are dominated by the Miami clay loam and the Miami silt loam, annually sell more than a million dollars worth of these two animal products. In fact, the chief form of animal industry consists of fattening beef cattle, the cattle being followed in the feed lot by hogs. Dairying is only developed in these counties to a limited extent where local markets or shipping facilities render it particularly profitable. In Michigan, however, the dairy industry rather exceeds in importance the fattening of beef cattle. Hogs are grown both on the dairy farms and with the beef cattle. In Wisconsin the type is found in the dairy section, and the growing of forage crops and the feeding of dairy cows are the chief industries.

SUMMARY.

A general consideration of the crop uses and adaptations of the soils of the Miami series indicates that the more gravelly and sandy soils of the series are relatively unimportant agriculturally because of limited total extent, defective moisture-holding capacity, and a generally rougher topography. Yet some of these soils, particularly the Miami fine sand and sandy loam, would constitute valuable special-crop soils if they were suitably located with respect to markets.

The Miami fine sandy loam, loam, silt loam, and clay loam comprise by far the greatest area of the soils of this series, and they are well suited with respect to topography, drainage and moisture conditions, and climatic surroundings to the growing of the most important staple crops of the temperate region. The Miami fine sandy loam is the coarsest textured soil of the series which is well suited to general farming. It is a fairly good soil for the production of corn, oats, and hay, and is well suited to the growing of beans and Irish potatoes. The occurrence of considerable areas of the type under special climatic conditions has encouraged its use for orcharding and the growing of grapes and small fruits.

The Miami loam is an excellent general-purpose soil, and is extensively used for the growing of corn, oats, and hay, with beans as the chief special crop. It is also suited to orcharding upon a domestic scale. Climatic conditions have favored the development of the dairy industry.

The Miami silt loam and clay loam are closely associated in geographic distribution, and are quite similar in their present crop uses. Owing partly to the climate both types are used chiefly for corn growing, with hay and oats occupying large acreages. Winter wheat is extensively grown upon both soils, giving moderate yields. The corn acreage is increasing while that in wheat is decreasing on both soil types. In general, the fattening of cattle and the raising of hogs constitute the chief forms of animal industry on both types, although the dairy industry is well developed in the more northern regions of their occurrence. Special crops, with the exception of tobacco and tomatoes, are not extensively grown.

The principal types of the series rank high as general farming soils, giving yields of the staple crops which equal or exceed the average of the States where they are most extensively developed. It is generally true that the heavier members of the series are much improved by tile underdrainage, while all of the types require the addition of organic matter in the surface soils either by the use of stable manure or the plowing under of green manure. It has been found that while the subsoils of the different types are generally calcareous, the application of lime to the surface soils is beneficial in conjunction with the growing of clover and other leguminous crops.

Practically all the available areas of the principal types have been cleared and are utilized for agricultural purposes, only the rougher land remaining in woodlots or in permanent pastures. While crop yields are, in general, satisfactory, it has been found that careful attention to crop rotation, the incorporation of organic manures, the use of commercial fertilizers with the small grain crops, liming, and tile underdrainage on the heavier types aid in increasing crop yields.

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